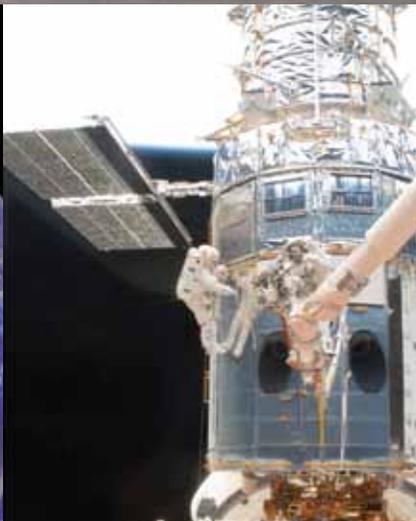


FY 2009

Performance and Accountability Report



Guide to NASA's Performance and Accountability Report

The National Aeronautics and Space Administration's (NASA) Fiscal Year 2009 (FY 2009) Performance and Accountability Report (PAR) provides a description of NASA's performance in achieving its long-term Strategic Goals, multi-year Outcomes, and Annual Performance Goals (APGs). This includes performance information and financial statements, as well as NASA's management challenges and NASA's plans and efforts to overcome them. This is a report to the American people on NASA's progress toward its Strategic Goals.

NASA's FY 2009 PAR meets relevant U.S. government reporting requirements (including the Government Performance and Results Act of 1993, the Chief Financial Officers Act of 1990, and the Federal Financial Management Improvement Act of 1996).

For FY 2009, NASA's consolidated PAR is organized as follows:

Management's Discussion and Analysis (MD&A)

The MD&A highlights NASA's overall performance, including programmatic, financial, and management activities. This section also includes NASA's organization, and describes its processes for assessing and rating performance, and its system of management controls (the organization, policies, and procedures) that help program and financial managers achieve results and safeguard the integrity of their programs.

Detailed Performance

The *Detailed Performance* section provides more in-depth information on NASA's progress toward achieving milestones and goals as defined in the Agency's Strategic Plan. It also includes plans for correcting performance measures that NASA did not achieve this year and a status of actions from the FY 2008 Performance Improvement Plan. The list of Outcomes and Annual Performance Goals (APGs) for FY 2009 are available in the FY 2009 Performance Plan Update, submitted with NASA's FY 2010 Budget Estimates.¹

Financials

The *Financials* section includes the Agency's financial statements, the audit results submitted by independent accountants in accordance with government auditing standards, and Agency responses to the audit findings.

Other Accompanying Information (OAI)

The OAI includes the Inspector General's statement on NASA's management and performance challenges, the status of the Agency's follow-up actions on the findings of the Inspector General's audits, an Improper Payments Information Act (IPIA) assessment, a summary of financial statement audit and management assurances, and Missions at a Glance, providing more details about flight missions mentioned in the PAR.

NASA's PAR is produced by the Office of Program Analysis and Evaluation, with contract support by The Tauri Group. If you have questions about NASA's PAR, please email hq-dl-parteam@mail.nasa.gov.

¹NASA's FY 2010 Budget Estimates can be found at www.nasa.gov/pdf/345225main_FY_2010_UPDATED_final_5-11-09_with_cover.pdf.

Message from the Administrator

November 16, 2009

I am pleased to present NASA's Performance and Accountability Report for FY 2009. This report presents NASA's progress toward achieving the challenging mission of space exploration, scientific discovery, and aeronautics research as outlined in our Strategic Plan. The performance and financial information presented in this report highlights our efforts to manage taxpayer dollars responsibly, while adhering to NASA's core values of Safety, Integrity, Teamwork and Excellence.

One of our most exciting accomplishments this year was the fourth and final Hubble Space Telescope orbiting observatory servicing mission. The crew of the Space Shuttle Space Transportation System-125 conducted five spacewalks to extend the life of the orbiting observatory and replace aging science instruments. Hubble has given our Nation and the world an unprecedented glimpse into the universe for nearly 20 years and the recent servicing mission ensures that Hubble will continue to provide that unique point-of-view for years to come.

This year, NASA launched missions to observe and better understand the Moon, search for new worlds, and help us understand Earth's climate systems. Our aeronautics program announced a clean-fuel prize, and won a prestigious award for its work in aviation safety. The International Space Station doubled our permanent human presence in space, and our Space Shuttle program safely flew five successful missions.

NASA makes every effort to ensure that performance data are subject to the same attention to detail as is devoted to our scientific and technical research. With this in mind, I can provide reasonable assurance that the performance data in this report is reliable and complete. Any data limitations are documented explicitly in the report.

In addition, NASA accepts the responsibility of accounting for and reporting on its financial activities. In FY 2009, NASA resolved one of the two prior year internal control material weaknesses. The successful resolution of the prior year material weakness in Financial Systems, Analyses, and Oversight resulted from improvements achieved through rigorous adherence to the Comprehensive Compliance Strategy, NASA's framework for ensuring compliance with Generally Accepted Accounting Principles and other financial requirements. The Agency also continued to make significant progress on NASA's one remaining material weakness—Controls over Legacy Property, Plant and Equipment (PP&E), related to valuation of legacy assets. The Agency believes it has now achieved compliance with the applicable updated accounting standard issued in October 2009 with respect to this class of assets. However, due to the fact that the new standard was issued subsequent to the end of the fiscal year, the material weakness in Controls over Legacy PP&E continues, as such, I am unable to provide reasonable assurance that this report's financial data is entirely reliable and fully complete. The Agency's efforts to address this weakness are discussed in the Statement of Assurance section of this report.

During my confirmation hearing, I spoke at length about challenge and leadership. I believe that NASA is an exceptional resource for this Nation, and have set a challenge for myself, as the new Administrator, to find innovative ways to use NASA's missions to enhance our nation's educational, scientific and technological capacity.

I look forward to leading the Agency through this exciting time of transition.



A handwritten signature in black ink, which appears to read "C. Bolden, Jr.", written over a light gray rectangular background.

Charles F. Bolden, Jr.
Administrator

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Management's Discussion and Analysis



Welcome to NASA



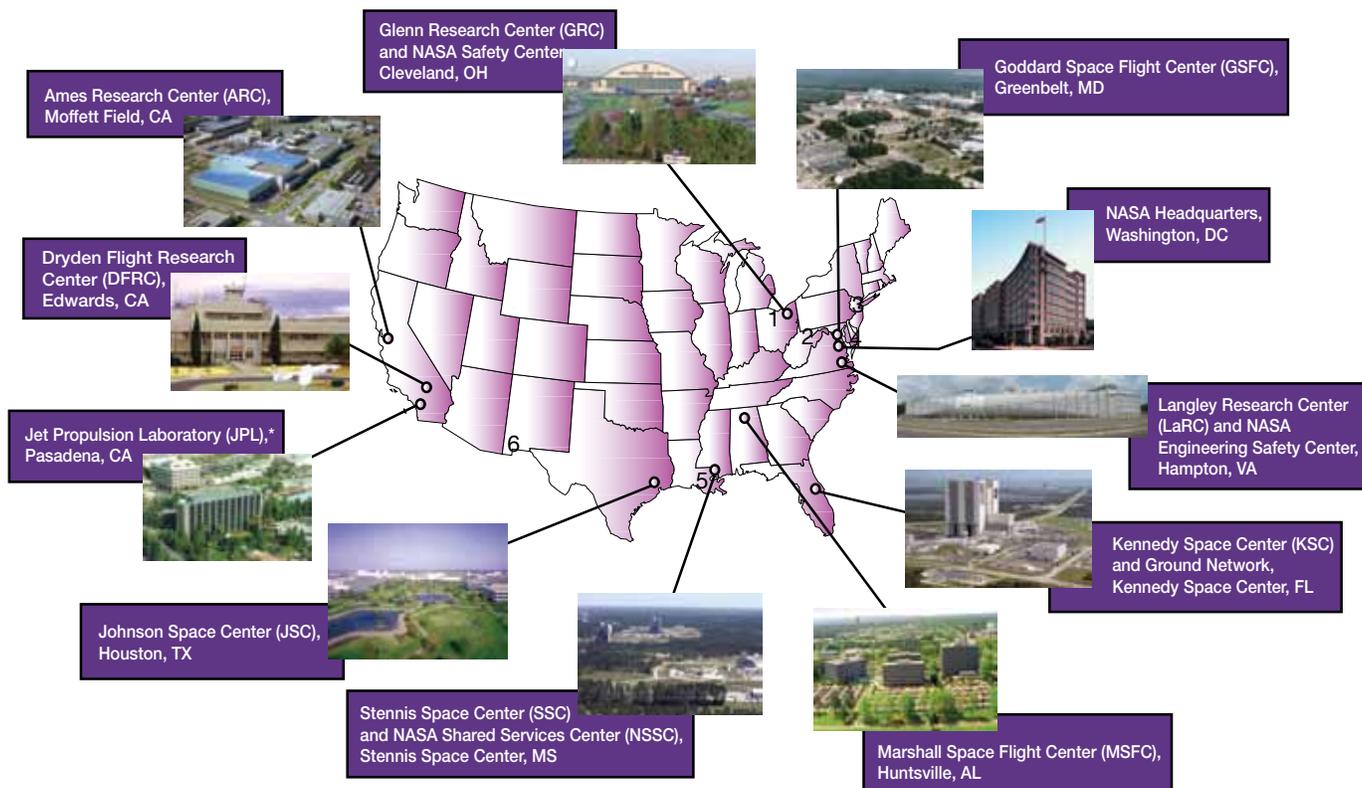
Our Mission

Congress enacted the National Aeronautics and Space Act of 1958 to provide for research into problems of flight within and outside the Earth's atmosphere and to ensure that the United States conducts activities in space devoted to peaceful purposes for the benefit of mankind. Our mission is:

To pioneer the future in space exploration, scientific discovery and aeronautics research.

NASA's Organization

NASA is comprised of its Headquarters in Washington, D.C., nine Centers located around the country, and the Jet Propulsion Laboratory, a Federally Funded Research and Development Center operated under a contract with the California Institute of Technology. In addition, we have partnership agreements with academia, the private sector, state and local governments, other Federal agencies, and a number of international organizations, creating an extended NASA family of civil servants, contractors, allied partners, and stakeholders.



*The Jet Propulsion Laboratory is a Federally Funded Research and Development Center, NASA-owned and managed under the terms of a contract with the California Institute of Technology. The workforce are employees of the California Institute of Technology.

Other NASA facilities include: 1 Plum Brook Station, Sandusky, OH, managed by GRC; 2 Software Independent Verification and Validation Facility, Fairmont, WV, managed by GSFC; 3 Goddard Institute for Space Studies, New York, NY, managed by GSFC; 4 Wallops Flight Facility, Wallops, VA, managed by GSFC; 5 Michoud Assembly Facility, New Orleans, LA, managed by MSFC; and 6 White Sands Test Facility and Space Network, White Sands, NM, managed by JSC.

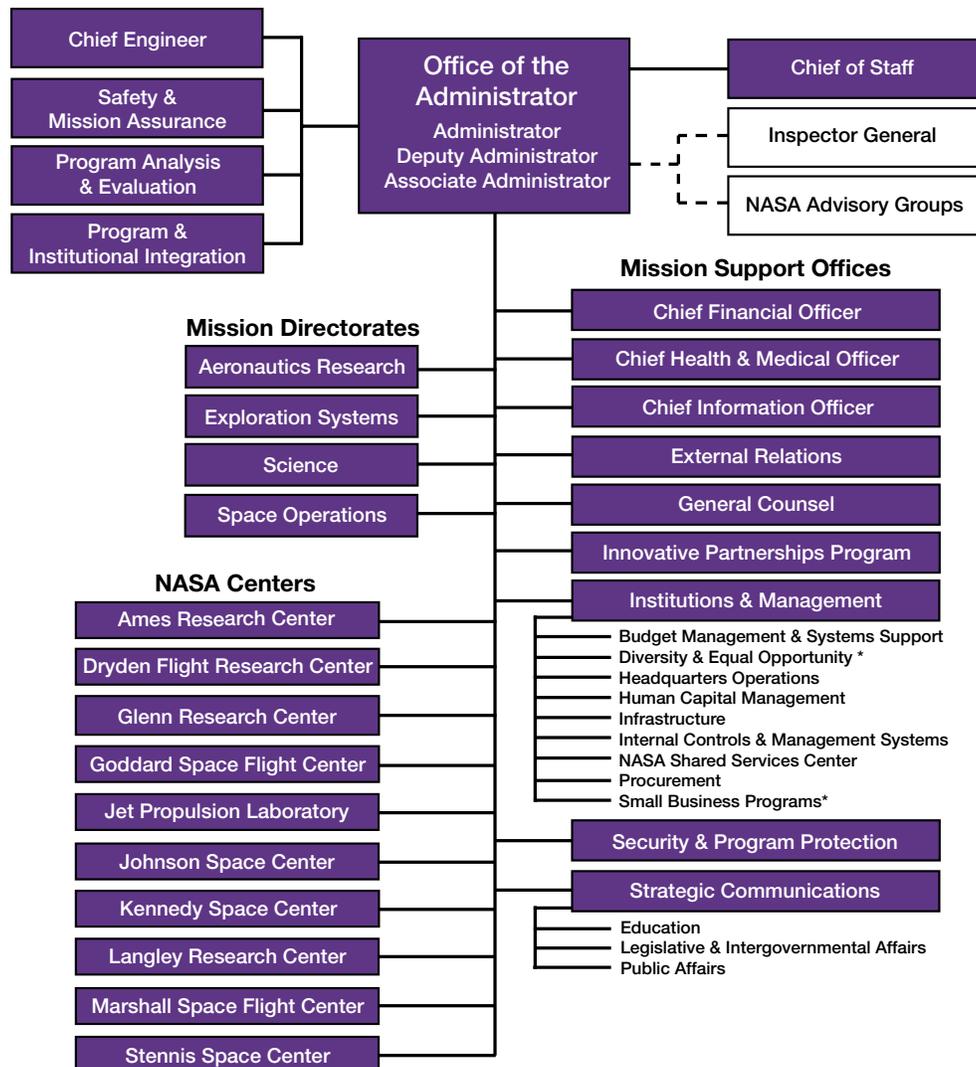
NASA's science, research, and technology development work is conceived of and implemented through its four Mission Directorates:

The **Aeronautics Research Mission Directorate (ARMD)** conducts fundamental research in aeronautical disciplines and develops capabilities, tools, and technologies that will significantly enhance aircraft performance, safety, and environmental compatibility, as well as increase the capacity and flexibility of the U.S. air transportation system.

The **Science Mission Directorate (SMD)** conducts the scientific exploration of Earth, the Sun, the solar system, and the universe. Missions include ground-, air-, and space-based observatories, deep-space automated spacecraft, and planetary orbiters, landers, and surface rovers. SMD also develops innovative science instruments and techniques in pursuit of NASA's science goals.

The **Exploration Systems Mission Directorate (ESMD)** develops the capabilities for long-duration human and robotic exploration. In support of the near-term goal of lunar exploration, ESMD is conducting robotic precursor missions, developing human transportation elements, creating innovative life support and medical technologies, and establishing international and commercial partnerships.

The **Space Operations Mission Directorate (SOMD)** directs spaceflight operations, space launches, and space communications and manages the operation of integrated systems in low Earth orbit and beyond, including the International Space Station (ISS). SOMD is laying the foundation for future missions to the Moon and Mars by using the ISS as an orbital outpost where astronauts can test systems and technology.



NASA organization as of September 30, 2009.

* In accordance with law or regulation, the offices of Diversity & Equal Opportunity and Small Business Programs maintain reporting relationships to the Administrator and Deputy Administrator.

White boxes indicate independent organizations that report to the Administrator.

NASA's Mission Support Offices ensure that critical support functions for facilities, resources (human, financial, material), and institutional systems are ready and available to maximize the success of the research, technology development, and operational missions. For more detailed information about the functions represented in the NASA organization go to www.nasa.gov/about/org_index.html.

NASA's Workforce

NASA employs over 18,000 civil servants at our nine Centers, Headquarters, and the NASA Shared Services Center, with an additional 5,000 people at the Jet Propulsion Laboratory. We have employees at facilities in 12 states and Washington, D.C. Having NASA employees spread out across the country means that much of the general U.S. public is close to a NASA Center or facility, and has the ability to develop a personal connection to NASA.

As we enter the second decade of the 21st century, there is a greater diversity of age in our workforce than ever before, with four generations working side by side in many of our organizations. Currently NASA is implementing new programs to pull more Generation Y workers, those with birth dates starting from the mid-1970s, into the NASA community as a way to strengthen our diversity and skill sets. New employees will be able to learn from expert employees, retaining valuable institutional knowledge that would otherwise be lost to future generations. The Office of Human Capital Management is implementing a new program called the Early-Career Hiring Initiative to increase the number of people hired for entry-level and early-career positions.

NASA remains one of the best places to work in the Federal government ranking third in the Partnership for Public Service's 2009 Best Places to Work survey of Federal agencies as identified by employees (see data.bestplaces-towork.org/bptw/index for more information). We ranked particularly high in strategic management, teamwork, leadership, and support of diversity. This ranking is a 2.8 percent improvement over the last survey, conducted in 2007. We are proud to provide this level of employee satisfaction and are committed to improving our ranking in the future.

Shared Values, Shared Results

NASA has four shared core values that support our commitment to technical excellence and express the ethics that guide our behavior. Every NASA employee believes that mission success is the natural outcome of an uncompromising commitment to safety, technical excellence, teamwork, and integrity.

Safety: Constant attention to safety is the cornerstone upon which we build mission success. We are committed, individually and as a team, to protecting the safety and health of the public, NASA team members, and the assets that the Nation entrusts to the Agency.

Integrity: We are committed to maintaining an environment of trust, built upon honesty, ethical behavior, respect, and candor. Our leaders enable this environment by encouraging and rewarding a vigorous, open flow of communication on all issues, in all directions, and among all employees without fear of reprisal. Building trust through ethical conduct as individuals and as an organization is a necessary component of mission success.

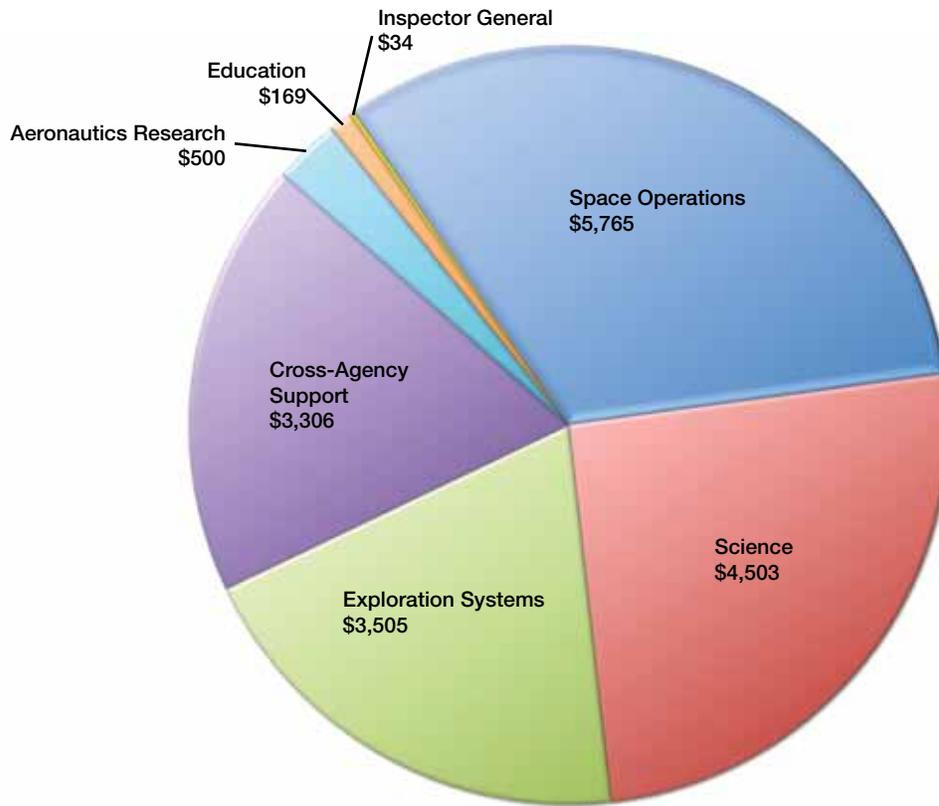
Teamwork: We strive to ensure that our workforce functions safely at the highest levels of physical and mental well-being. The most powerful tool for achieving mission success is a multi-disciplinary team of diverse, competent people across all NASA Centers. Our approach to teamwork is based on a philosophy that each team member brings unique experience and important expertise to project issues. Recognition of and openness to the insight of individual team members improves the likelihood of identifying and resolving challenges to safety and mission success. We are committed to creating an environment that fosters teamwork and processes that support equal opportunity, collaboration, continuous learning, and openness to innovation and new ideas.

Excellence: To achieve the highest standards in engineering, research, operations, and management in support of mission success, we are committed to nurturing an organizational culture in which individuals make full use of their time, talent, and opportunities to pursue excellence in both the ordinary and the extraordinary.

Budgeting for Performance: NASA's FY 2009 Budget

NASA's Fiscal Year (FY) 2009 budgetary resources totaled \$17,782 million, an increase of about 2.2 percent from NASA's FY 2008 Budget. This increase demonstrates a commitment to funding the balanced priorities set forth for the Agency in space exploration, Earth and space science, and aeronautics research.

NASA's FY 2009 Enacted Budget Total: \$17,782
(Dollars in Millions)



Note: Amounts do not include Recovery Act funds.

Proud to Serve the Nation: American Recovery and Reinvestment Act

The American Recovery and Reinvestment Act of 2009 (Recovery Act) was signed into law by President Obama on February 17, 2009. It is an unprecedented effort to jumpstart our economy, create and save millions of jobs, and modernize our Nation's infrastructure so our country can thrive in the 21st century.

We received \$1,002 million in Recovery Act funds. Details on our progress are available at www.nasa.gov/recovery/index.html. From satellites that track and trend weather and natural hazards to creating a safer, more efficient air transportation system, our employees are proud to contribute to the breakthroughs and activities that will aid America's economic recovery.

NASA Recovery Act Funding Total: \$1,002

(Dollars in Millions)

- Undertake systems-level research, development, and demonstration activities related to aviation safety, environmental impact mitigation, and development of the Next Generation Air Transportation system (NextGen).

- Accelerate the development of Earth Science climate research missions recommended by the National Academies' Decadal Survey.
- Increase NASA's supercomputing capabilities.

Inspector General
\$2

Aeronautics Research
\$150

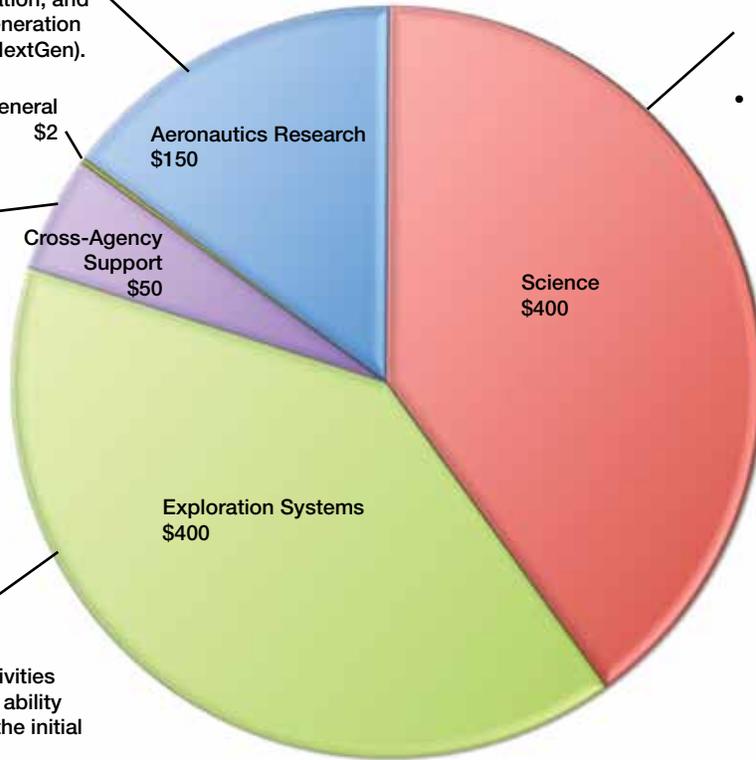
- Restore NASA-owned facilities damaged by hurricanes and other natural disasters that occurred in 2008.

Cross-Agency
Support
\$50

Science
\$400

Exploration Systems
\$400

- Fund critical mission activities that will improve NASA's ability to maintain the date for the initial operational capability.
- Stimulate efforts within the private sector to develop and demonstrate human spaceflight capability.



Performance Results

Managing and Measuring NASA's Performance

The Government Performance and Results Act of 1993 (GPRA) requires Federal agencies to issue plans for how they plan to spend budgeted resources and what they intend to achieve with this investment. This process starts with a strategic plan that sets the mission and outlines an agency's goals and objectives for at least five years. The agency's annual performance plan then describes the performance indicators and program outputs needed to achieve the goals and objectives.

NASA's 2006 Strategic Plan² established six Strategic Goals, with six Sub-goals under Strategic Goal 3.

Strategic Goal 1: Fly the Shuttle as safely as possible until its retirement, not later than 2010.

Strategic Goal 2: Complete the International Space Station in a manner consistent with NASA's International Partner commitments and the needs of human exploration.

Strategic Goal 3: Develop a balanced overall program of science, exploration, and aeronautics consistent with the redirection of the human spaceflight program to focus on exploration.

Strategic Goal 4: Bring a new Crew Exploration Vehicle into service as soon as possible after Shuttle retirement.

Strategic Goal 5: Encourage the pursuit of appropriate partnerships with the emerging commercial space sector.

Strategic Goal 6: Establish a lunar return program having the maximum possible utility for later missions to Mars and other destinations.

Each of the six Strategic Goals is clearly defined and supported by multi-year Outcomes that enhance our ability to measure and report our accomplishments. We also set Annual Performance Goals (APGs) that demonstrate progress for achieving our Outcomes. The APGs are updated annually as part of NASA's Performance Plan³ and are included in NASA's annual Budget Estimates.

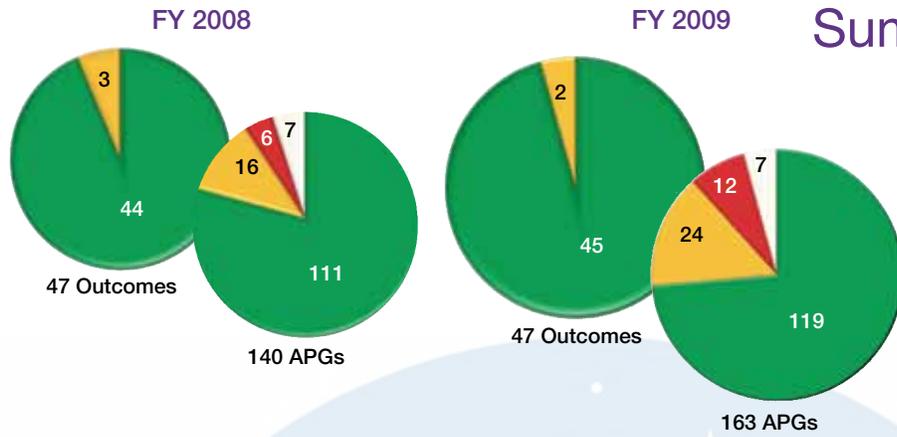
Progress toward achieving NASA's Outcomes and APGs is measured and communicated via color ratings (red, green, yellow, and white). NASA managers in the Mission Directorates and Mission Support Offices determine ratings for the multi-year Outcomes and APGs based on a series of internal and external assessments that are part of ongoing monitoring requirements in NASA's Performance Management System.

What do the color ratings mean?		
Color	Multi-year Outcome Rating	Annual Performance Goal Rating
Green	NASA achieved most APGs under this Outcome and is on-track to achieve or exceed this Outcome.	NASA achieved this APG.
Yellow	NASA made significant progress toward this Outcome, however, the Agency may not achieve this Outcome as stated.	NASA failed to achieve this APG, but made significant progress and anticipates achieving it during the next fiscal year.
Red	NASA failed to achieve most of the APGs under this Outcome and does not expect to achieve this Outcome as stated.	NASA failed to achieve this APG and does not anticipate completing it within the next fiscal year.
White	This Outcome was canceled by management directive or is no longer applicable based on management changes to the APGs.	This APG was canceled by management directive and NASA is no longer pursuing activities relevant to this APG, or the program did not have activities relevant to the APG during the fiscal year.

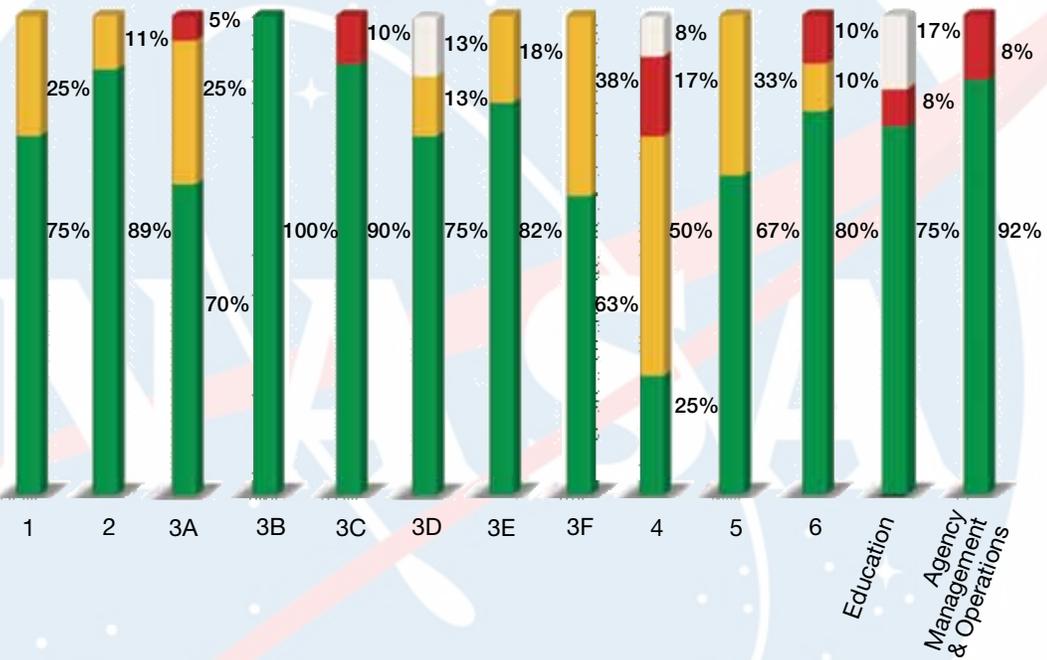
³NASA's 2006 Strategic Plan can be found at www.nasa.gov/pdf/142303main_2006_NASA_Strategic_Plan_sm.pdf.

⁴NASA's FY 2009 Performance Plan can be found at www.nasa.gov/pdf/344569main_FY09_section_of_MPP.pdf.

Summary of NASA's Performance



FY 2009 APG Ratings by Strategic Goal or Equivalent



FY 2009 Cost by Strategic Goal (Dollars in Millions)



Total cost is \$22,467.

Amounts in the chart may not agree with the total, as per the Statement of Net Cost, or totals in Detailed Performance due to rounding.

Managers rely on feedback from advisory groups and experts in the field to guide their rating decisions. Advisory groups such as the NASA Advisory Council, the National Academies, and the Aerospace Safety Advisory Panel, assess program content and direction. Experts from the science community also review our progress toward meeting the performance measures under Sub-goals 3A through 3D, and, managers assign ratings to the science-related Outcomes and APGs based on these experts' findings. The previous page shows a breakdown of the FY 2009 performance results by percentages of Green, Yellow, Red, and White ratings for the Outcomes and APGs.

Our performance data provides a foundation for both programmatic and institutional decision-making processes and supports decisions concerning strategy and budget. Internally, we monitor and analyze how each program manages its budget and schedule. These analyses are provided during quarterly and monthly reviews at the Center, Mission Directorate, and Agency levels to communicate the health and performance of a program. The final performance results reflected in this report will inform our planning for the upcoming Strategic Plan (due to be released in early 2010) and the FY 2011 budget request.

FY 2009 Cost Toward Strategic Goals

To measure cost toward Strategic Goals and Sub-goals, NASA maps the Mission Directorate's costs (i.e., Lines of Business as presented in the Statement of Net Cost) to the Strategic Goals and Sub-goals via Themes and programs. In 2003, we created Themes as a bridge to connect related Agency programs and projects to the Mission Directorates or equivalents that manage the programs. Themes group together similar programs, such as the programs that conduct Earth science or support the Agency's spaceflight missions, into budgeting categories. NASA uses Themes and programs to track performance areas, with Themes often contributing to a single Strategic Goal or Sub-goal, with a few exceptions.

NASA analyzes the fiscal year Operating Plan to determine the portion of each Mission Directorate budget allocated to each Theme and/or program, thus tying it to a particular Strategic Goal or Sub-goal. Our analysts then use NASA's financial statements, in particular the Statement of Net Cost, to allocate Line of Business cost to the Themes and then Strategic Goals and Sub-Goals based on the relationships determined in the Operating Plan, as displayed in the previous page.

Performance Highlights

The following section highlights NASA's significant achievements and efforts under each Strategic Goal in FY 2009. For complete ratings and narratives describing NASA's progress toward achieving our APGs, multi-year Outcomes and Strategic Goals, please see the *Detailed Performance* section. For more information on NASA's missions, please see the NASA's Missions at a Glance located in the *Other Accompanying Information* section of this document.

Goal 1: Fly the Shuttle as safely as possible until its retirement, not later than 2010.

Responsible Mission Directorate: Space Operations

The Space Shuttle Program flew five successful Shuttle missions in FY 2009, increasing the crew size on the International Space Station (ISS) and refurbishing the Hubble Space Telescope. In March, the Space Transportation System (STS)-119 mission delivered the final set of ISS solar arrays, the last major ISS structure needed to accommodate a six-person crew.

The first six-person ISS crew flew in May, which combined with the seven crewmembers who flew to the ISS on STS-127 in July, allowed NASA and the International Partners to set a record for the largest group of people ever to live and work in space at one time. A full six-person crew gives the U.S. and our International Partners the ability to use the ISS for science and operations, and means that all partner nations have a greater chance to fly their astronauts to the ISS.

Also in May, STS-125 completed the last Hubble Space Telescope servicing mission, upgrading and refurbishing the 19 year-old telescope. The crew conducted five spacewalks, each lasting between seven and eight hours, on five consecutive days, often using real-time fixes to complete complex tasks. The crew installed the new Wide Field Camera 3, which allows Hubble to take large-scale, extremely clear and detailed pictures at ultraviolet and infrared wavelengths, a dramatic improvement over all previous Hubble cameras. They installed the Cosmic Origins

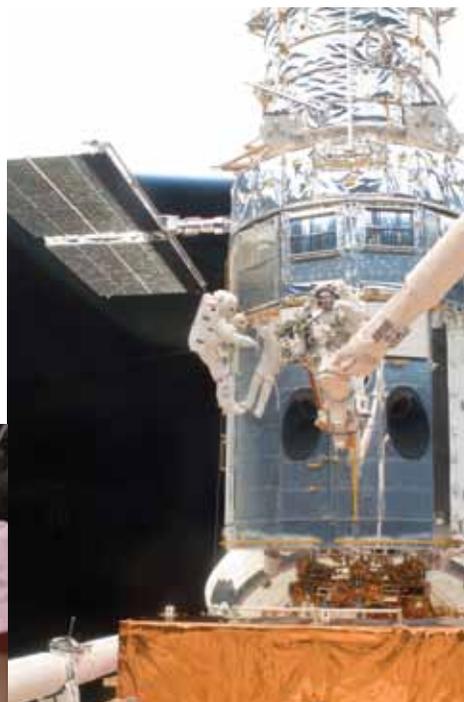
John Grunsfeld (above) faces a reflection of himself in the shiny, mirror-like surface of the Hubble Space Telescope, while Andrew Feustel approaches on the end of the remote manipulator system arm. The telescope is temporarily captured by Atlantis so that the astronauts can safely perform their work. The two mission specialists are performing the first of five STS-125 spacewalks. Mission specialists Megan McArthur and Mike Massimino (inset) work controls, such as the controls for the remote manipulator system arm, on the aft flight deck during flight day three activities. President Barack Obama (inset) talks to the crew before they go to sleep on flight day 10, the day after they released the freshly serviced telescope. "Like a lot of Americans, I've been watching with amazement the gorgeous images you've been sending back, and the incredible repair mission you've been making in space," the President said. "I think you're providing a wonderful example of the kind of dedication and commitment to exploration that represents America and the space program generally. These are traits that have always made this country strong, and all of you personify them."



Credit: NASA /White House/P. Souza



Credit: NASA



Credit: NASA

Spectrograph, which can observe faint, far-away light sources that provide clues to the evolution of galaxies and the origin of stellar and planetary systems. The STS-125 crew also performed a tune-up, replacing old gyroscopes, batteries, and a fine guidance sensor, which locks onto stars as part of the pointing system.

In addition to the Hubble servicing mission and setting a world space record, the four Shuttle flights to the ISS delivered the final international laboratory module (a series of Japanese elements), the last of four solar power arrays (each as long as the width of a football field), and several tons of hardware, supplies, and research equipment. For more about recent and upcoming Space Shuttle missions, go to www.nasa.gov/topics/shuttle_station/index.html.

Goal 2: Complete the International Space Station in a manner consistent with NASA's International Partner commitments and the needs of human exploration.

Responsible Mission Directorate: Space Operations

On December 4, 1998, Space Shuttle Endeavour (STS-88) lit the night sky as it launched toward an historic moment: the first construction mission for the ISS, attaching the U.S. Unity node to the Russian Zarya module already in orbit. Once the two parts were joined, Commander Robert Cabana and Cosmonaut Sergei Krikalyov were the first people to enter the new outpost in low Earth orbit. NASA and our International Partners celebrated 10 years of success with a busy year of work towards completing the ISS. In November 2008, the STS-126 mission delivered the equipment necessary to double the crew size of the ISS, including a galley, crew quarters, a waste and hygiene compartment, and a water recovery system that recycles urine into clean, clear drinking and coolant water. This capability is critical for weaning the ISS from dependence on the Space Shuttle for water resupply, preparing it for the Shuttle fleet's planned retirement in 2010 while also testing a critical technology for future space exploration. With the addition of the final set of solar arrays, delivered by the STS-119 crew in March, the ISS was ready to accommodate its first six-person crew at the end of May. The STS-119 mission also delivered astronaut Koichi Wakata, the Japan Aerospace Exploration Agency's (JAXA's) first ISS crewmember. In July, the STS-127 mission delivered the final



Credit: NASA

November 18, 2008, Astronauts perform a spacewalk to clean and lubricate part of the ISS's starboard Solar Alpha Rotary Joints (SARJ) and to remove two of SARJ's 12 trundle-bearing assemblies.

piece of JAXA's Kibo laboratory, the Japanese Experiment Module–Exposed Facility, a permanent “porch” that allows experiments to be exposed to the space environment.

An important part of achieving Strategic Goal 2 is turning the ISS into an effective on-orbit research laboratory for testing technologies and capabilities for space exploration and Earth applications. As part of the International Partner commitments, the crew share facilities and help each other on research projects, making the most of available resources as the outpost approaches full operations. The STS-126 mission delivered the Multi-user Droplet Combustion Apparatus, a modular insert for the Combustion Integrated Rack that holds fire suppression and flame extinguishment experiments. The first experiment conducted in the new apparatus, the Flame Extinguishment Experiment, tested the performance of fire suppressants in space with the goal of selecting fire suppressants for the next generation of space capsules, like Orion. The Smoke Point in Coflow Experiment studied the point at which gas jet flames begin to emit soot, important for soot control in combustors ranging from jet engines to coal-burning power plants.

The Crew also participated in the Integrated Cardiovascular investigation to determine how much the heart muscle decreases in size while crew are on the ISS and how effective their current exercise program is at protecting their heart strength. Three International Partner agencies—NASA, the European Space Agency (ESA), and the Canadian Space Agency—are working together on the investigation. More information on the many ISS experiments conducted during each Expedition can be found at www.nasa.gov/mission_pages/station/main/index.html.

Goal 3A: Study Earth from space to advance scientific understanding and meet societal needs.

Responsible Mission Directorate: Science

On September 26, 2009, tropical storm Ketsana hit the Philippines, causing record flooding in the capital, Manila, on the island of Luzon and killing over 200 people. After passing through the Philippines, Ketsana intensified into a typhoon over the central South China Sea and made landfall near Da Nang along the central coast of Vietnam. NASA's suite of Earth observing satellites are providing NASA scientists and users around the world with many vital measurements to capture weather events like Ketsana to increase our understanding of the Earth's climate, improve weather forecasting, and assist disaster mitigation efforts.

Over the past year, a team of researchers published in the *Journal of the Meteorological Society of Japan* (volume 87A, 2009) a new climatology of tropical surface rain based on 10 years of precipitation retrievals and analyses from the TRMM satellite, a joint mission between NASA and the Japan Aerospace Exploration Agency (JAXA). TRMM is designed to help our understanding of the water cycle in the current climate system. By covering the tropical and semi-tropical regions of Earth, TRMM provides much-needed data on rainfall and the heat release associated with rainfall. Responsible for three quarters of the energy that drives the global atmospheric circulation, tropical rainfall can be said to drive Earth's “Climate Machine.”

Using TRMM data NASA scientists (Lau et al., *Journal of Geophysical Research*, 2008) have found in recent decades (1979 through 2005) a positive trend in heavy to very-heavy rainfall in the tropical Atlantic during the July through November season. They also found that tropical cyclones are



Credit: NASA

ESA astronaut Frank De Winne, Expedition 20 flight engineer, works with the InSPACE-2 investigation in the ESA-built Microgravity Science Glovebox—an enclosed research facility for working with messy or potentially hazardous materials. The investigation is studying suspensions of paramagnetic particles that can quickly solidify when exposed to a magnetic field and return to their original liquid state when the magnetic field is removed. This unique behavior could be used to improve or develop new brake systems or robotics.



Credit: NASA/MODIS Rapid Response Team

The MODIS instrument on NASA's Terra satellite captured this view of Ketsana on the morning of September 28, 2009, local time, as it approached Vietnam. It made landfall the next day.

increasingly more energetic and have contributed to increased extreme heavy rainfall events, due to both accumulated longer storm duration and heavier rain per storm day. These results are consistent with previous studies regarding the more frequent occurrence of extreme rain events in recent decades, and offer new scientific insights into the possible linkage between hurricane intensity and global warming.

Working with partners at the National Oceanic and Atmospheric Administration (NOAA) weather forecast offices, measurements from the NASA Atmospheric Infrared Sounder (AIRS), the Lightning Mapping Array (LMA), and the Moderate Resolution Imaging Spectroradiometer (MODIS) instruments continue to improve the skills of operational weather forecasts. Goddard Space Flight Center scientists recently implemented a new assimilation modeling scheme of AIRS temperature retrievals and demonstrated significant improvement in the “hindcasting” of cyclone Nargis, which killed around 100,000 people in Myanmar in May 2008 (Reale et al., 2009, *Geophysical Research Letters* 36). Researchers use retrospective analysis, or hindcasting, to plot the precise course of storms that have already happened. Hindcasting helps researchers reveal trends that can improve forecasting. By directly assimilating cloud-cleared temperature profiles instead of radiances typically rejected by the numerical prediction models in cloud scenes, the displacement error in the five day forecast was less than 31 miles of the actual landfall, as opposed to approximately 125 miles in the typical forecast. The improvement came from retrieval information in the presence of clouds, while radiance assimilation schemes stringently reject all cloudy scenes. The improvement came from retrieval information in the presence of clouds, while radiance assimilation schemes stringently reject all cloudy scenes.

Goal 3B: Understand the Sun and its effects on Earth and the solar system.

Responsible Mission Directorate: Science

Even though Earth is 93 million miles away from the Sun, our planet is affected by what happens on the Sun’s surface. Sunspots are planet-sized islands of magnetism on the surface of the Sun and are the sources of solar flares and coronal mass ejections that produce streams of high-energy particles and radiation. These outbursts can harm life, alter its evolution, and disrupt many processes on Earth including satellite communications and global positioning system applications. For astronauts working in space, sunspot activity can pose a greater radiation risk and compromise spacecraft systems.

Sunspots typically occur in an 11-year cycle with minimal sunspot activity—or solar minimum—occurring at one end of the cycle and more intense sunspot activity—or solar maximum—occurring at the other end. At their most extreme, the solar minimum and solar maximum can affect weather patterns. For example, scientists think that an extended solar minimum may have contributed to a period from 1645 to 1715, often referred to as the Little Ice Age, of harsh winters, torrential rains, and crop failures across the Northern Hemisphere.

We are currently in an extended solar minimum and 2009 has been the quietest year on the Sun since 1913. A number of NASA missions—SOHO, AIM, the CINDI instrument aboard the U.S. Air Force’s C/NOFS spacecraft, the five THEMIS probes, the twin STEREO imagers, TRACE, and others—have been observing different aspects of this solar minimum. In 2008, there were 266 spotless days, and up through September 30, there were 215 days without sunspots for 2009.

Measurements by the Ulysses spacecraft show that solar wind pressure has dropped 20 percent since the mid-1990s. The solar wind helps keep galactic cosmic rays out of the inner solar system. With the solar wind flagging, more cosmic rays reach Earth, resulting in increased health hazards for astronauts. Weaker solar wind also means fewer geomagnetic storms and auroras, the beautiful northern and southern (polar) lights we see on

This composite image, taken on August 7, 2009, is made by combining two images taken 12 hours apart by the STEREO spacecraft to provide a three-dimensional extreme ultraviolet image of the quiet Sun. In those 12 hours, the Sun has rotated around enough to create a sufficiently separated perspective to create 3D. The Sun in extreme ultraviolet light shows us a dark coronal hole near the central line and northern pole from which fast solar wind is streaming. We also can see loops of magnetic field lines arcing out and above a small active region to the lower right. Images in ultraviolet light reveal the detailed structure of the deep solar atmosphere as compared to visible light that looks at the near featureless surface of the Sun (photosphere). These image colors are suitable for right eye/left eye 3D anaglyph viewing.



Earth. Measurements by other NASA spacecraft show that the Sun's brightness has dimmed 0.02 percent at visible wavelengths and six percent at extreme ultraviolet wavelengths since the solar minimum of 1996. One effect of this change is that the upper atmosphere is less heated and not as "puffed up," which means that satellites in low Earth orbit experience less atmospheric drag, extending their operational lifetimes.

All of the observations by NASA spacecraft suggest that the upcoming solar cycle may be significantly different than previously observed cycles. Understanding our Sun's connection to Earth as an integrated system is essential to protecting technologies on Earth from space weather effects and enhances the productivity and safety of space explorers.

Goal 3C: Advance scientific knowledge of the origin and history of the solar system, the potential for life elsewhere, and the hazards and resources present as humans explore space.

Responsible Mission Directorate: Science

Scientists are trying to solve the mystery of one of the most recognizable features in the solar system—Saturn's rings. We do not know if Saturn's rings formed back in the early stages of the solar system (about four billion years ago) or formed as recently as when dinosaurs roamed on Earth (about 65 million years ago). Regardless of when they first formed, we do know that the rings we observe today were not all created in exactly the same way. Understanding how these beautiful rings formed will give us insight into how the outer solar system evolved. Thanks to an event that occurred this year, NASA has gathered a treasure trove of data that may solve some of Saturn's mysteries.

Saturn orbits the Sun every 30 years. Twice during Saturn's orbital trip—or every 15 years—sunlight hits Saturn's rings exactly edge-on, making them all but disappear. On August 11, 2009, Saturn's equinox revealed bumps as high as the Rocky Mountains in Saturn's rings. Previously, scientists thought these bumps were about the size of a two-story building; instead, one ridge of icy ring particles, whipped up by the gravitational pull of Saturn's moon Daphnis as it travels through the plane of the rings, looms as high as 2.5 miles. It is the tallest vertical wall seen within the rings.

At the same time the Cassini spacecraft snapped visible-light photographs of Saturn's rings, its Composite Infrared Spectrometer instrument was taking the rings' temperatures. During the equinox, the rings cooled to the lowest temperature ever recorded. The A ring dropped down to a frosty 382 degrees below zero Fahrenheit. Studying ring temperatures at equinox will help scientists better understand the sizes and other characteristics of the ring particles.



Credit: NASA/JPL/Space Science Institute

This view, taken by the Cassini spacecraft in a series of 15 images, is only possible around the time of Saturn's equinox, which occurs every half-Saturn-year. The equinox lowers the Sun's angle to the ring plane, significantly darkens the rings, and causes out-of-plane structures to cast long shadows across the rings. Cassini's cameras have spotted not only the predictable shadows of some of Saturn's moons, but also the shadows of newly revealed vertical structures in the rings themselves. The gentle, spiraling undulation discovered in 2006 extending across the D ring is now seen, under better viewing conditions, to extend fully across the C ring, right up to the inner B ring. In 2006, imaging scientists speculated that a collision with a comet or asteroid may have disturbed the D ring. That explanation seems less likely now that this and other new images show the effect spread over a much broader radial range, covering a radial distance of about 11,000 miles. The enormous extent of the corrugation now makes its existence more mysterious than ever, and imaging scientists are struggling to understand its origin. Further outward, a bending wave, created by a resonance with the moon Iapetus, can be easily seen just beyond the Cassini Division, leading into the inner A ring. The shadow of the moon Dione is seen in several locations on the rings because of the shadow's motion across the rings during the time the mosaic images were being acquired.

Scientists also were intrigued by bright streaks in two different rings that appear to be clouds of dust kicked up in collisions between small space debris and ring particles, which were easier to see under the low-lighting conditions of equinox. Understanding the rate and locations of impacts will help them build better models of contamination and erosion in the rings and refine estimates of their age.

Goal 3D: Discover the origin, structure, evolution, and destiny of the universe, and search for Earth-like planets.

Responsible Mission Directorate: Science

Astronomers have taken a direct image of an extra solar planet with the Hubble Space Telescope. The planet circles the bright southern star Fomalhaut, located in the constellation Piscis Australis. The astronomers estimate that the planet, called Fomalhaut b, is no more than three times Jupiter's mass, which is enormous compared to Earth but a proverbial needle in a haystack for planet hunters, considering it is located 25 light-years away. Since the Fomalhaut system is only 200 million years old—extremely young by planetary standards—images like this help astronomers study how planets and planetary systems evolve around stars, an important step toward achieving Sub-goal 3D.

Fomalhaut has been a candidate for planet hunting ever since an excess of dust was discovered around the star in the early 1980s by NASA's Infrared Astronomy Satellite (IRAS). Then in 2004, the coronagraph (which blocks out a star's bright glare so that nearby objects can be resolved) in the High Resolution Camera on Hubble's Advanced Camera for Surveys produced the first-ever resolved visible-light image of a large dust belt surrounding the star. It clearly showed that the dust belt has a ring of protoplanetary debris, similar to the Kuiper Belt encircling our solar system, which could evolve into a planetary system.

Hubble astronomers proposed in 2005 that the ring was being gravitationally modified by a planet lying between the star and the ring's inner edge. Evidence came from Hubble's confirmation that the ring is offset from the center of the star. The sharp inner edge of the ring is also consistent with the presence of a planet that gravitationally "shepherds" ring particles. Independent researchers have subsequently reached similar conclusions. Now, Hubble has actually photographed a point source of light lying 1.8 billion miles inside the ring's inner edge.

Future observations will attempt to see Fomalhaut b in the near- and mid-infrared, giving scientists more clues about characteristics of the planet and its potential to support life. For more about our Astrophysics programs, go to www.nasa.gov/topics/universe/index.html.

Goal 3E: Advance knowledge in the fundamental disciplines of aeronautics, and develop technologies for safer aircraft and higher capacity airspace systems.

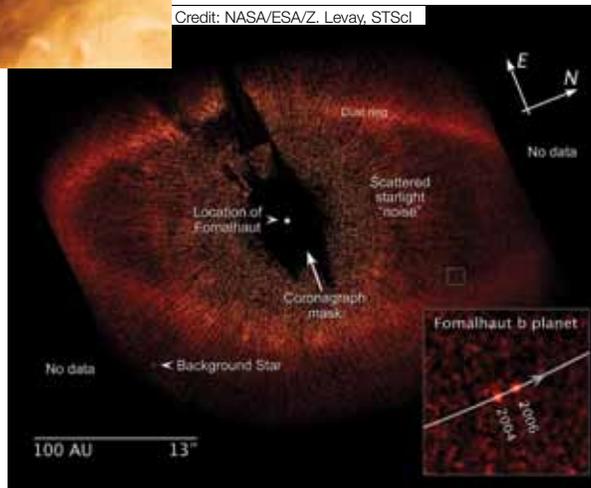
Responsible Mission Directorate: Aeronautics Research

Keeping aviation accidents rare, as commercial air transport of passengers and cargo grows, demands improvements in the intrinsic safety of current and future aircraft. Therefore, NASA researchers have developed an innovative method for the on board estimation of aircraft jet engine health and performance to help avoid engine failures and more accurately identify the need for engine maintenance.

The small white box at lower right pinpoints the location of planet Fomalhaut b, which has carved a path along the inner edge of a vast, dusty debris ring encircling its parent star, Fomalhaut. The inset at bottom right is a composite image showing the planet's position during Hubble observations taken in 2004 and 2006. Astronomers have calculated that Fomalhaut b completes an orbit around its parent star every 872 years. The white dot in the center of the image marks the star's location. The black region around the star is where the Advanced Camera's coronagraph has blocked out glare. The inset artist's view shows how the planet might look in its neighborhood of dusty debris.



Credit: NASA/ESA/Z. Levay, STScI



Credit: NASA/ESA/Z. Levay, STScI

NASA researchers have developed an innovative method for the on-board estimation of aircraft engine performance parameters that can be used by aircraft engine controls and health management applications to help avoid engine failure, improve aircraft safety, and move us toward achieving Sub-goal 3E.

Engine components wear over time, affecting an aircraft engine's performance. The level of engine degradation is described in terms of immeasurable health parameters like the efficiency or flow capacity of each major engine component. Using mathematical techniques, researchers can estimate the health parameters and level of engine performance degradation. To do this with enough accuracy, the researchers must place sensors throughout the engine equal to or greater than the number of parameters they need to estimate. However, the number of sensors available throughout an engine is typically less than required.

A common approach to address this shortcoming is to estimate a sub-set of the health parameters, though this can introduce significant error in the estimation of overall engine health and performance. Therefore, our Integrated Vehicle Health Management project has developed an innovative method that enables estimation of all health parameters such that the overall engine health and performance estimation error is minimized. Project researchers have validated the new methodology in simulations using an aircraft turbofan engine model. The results agreed with theoretical predictions and demonstrated that applying the enhanced technique resulted in a 31.6 percent reduction in average estimation error compared to a conventional approach.

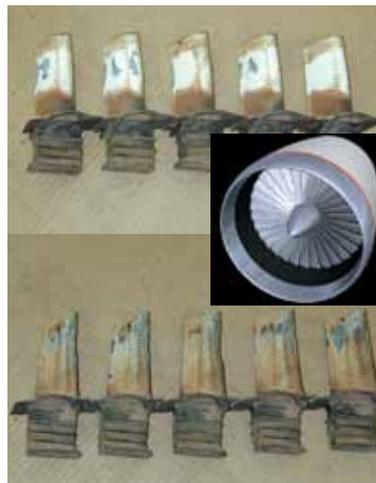
For more about our Aeronautics programs, go to www.nasa.gov/topics/aeronautics/index.html.

Goal 3F: Understand the effects of the space environment on human performance, and test new technologies and countermeasures for long-duration human space exploration.

Responsible Mission Directorates: Exploration Systems and Space Operations

Keeping astronauts healthy and productive in space goes beyond medicine and exercise. It includes technologies that protect crewmembers while remaining practical and comfortable to use. In October, NASA tested the pickup truck-sized pressurized Lunar Electric Rover, a transport and mini-habitat for two crewmembers in the Arizona desert.

Until recently, NASA operated the vehicle chassis as an unpressurized rover that required crewmembers to be suited. By adding a pressurized module on top, the crewmembers can shed the cumbersome spacesuits and steer from inside the mobile habitat. The spacesuits attach to the outside of the rover and the crewmembers transfer via a suit-port interface. The pressurized rover, which can serve as a roaming home for two people, has separate sleeping areas, sanitary facilities, and a modular design that allows various tools like bulldozer blades to be added for special



Credit: NASA

Years of wear are shown on aircraft turbofan engine blades in these photos. An integral part of the fan, visible at the center of the illustration, the blades propel a continuous airstream into the engine's combustion chamber. If the blades become overly degraded, due to age or ingestion of debris during flight, they can hamper engine performance or cause engine failure. NASA's Integrated Vehicle Health Management project has developed an improved method to estimate aircraft engine health parameters and engine performance degradation.



Credit: NASA

For the October 2008 test, called Desert RATS, engineers, geologists, and astronauts came together at Black Point Lava Flow in Arizona to test our new Lunar Electric Rover. Using a spacesuit alone, an astronaut only has about eight hours to explore and conduct research before having to return to a central base. In the rover, two crewmembers can drive for days or weeks, suiting up only when they need to get a closer look or gather a sample. Tests like this help us work out glitches in a safe, analog environment and gather lessons learned. For example, the team learned that they could change a flat tire while wearing spacesuits.

missions. The rover also features pivoting wheels and active suspension that allows it to raise and lower as necessary to go over obstacles and get close to interesting geological features. Then crewmembers can climb through the suit-port into their spacesuits and begin exploring the area with considerable speed and ease.

Astronaut Mike Gernhardt and planetary geologist Pascal Lee tested the rover and were both impressed. Gernhardt reported that the habitat never felt cramped or confined; an important feature for longer missions. The test also showed that the rover could be used for lunar geological surveys. "For a geologist thinking about the best way to explore the Moon or Mars, it is a dream come true," Lee said. "I really think NASA is on the right track with this concept."

For more on our research to keep astronauts healthy and productive, go to humanresearch.jsc.nasa.gov and www.nasa.gov/exploration/analogs/index.html.

Goal 4: Bring a new Crew Exploration Vehicle into service as soon as possible after Shuttle retirement.

Responsible Mission Directorate: Exploration Systems

NASA's Constellation Program completed several milestones this fiscal year. For example, the Orion project completed several major tests and its Preliminary Design Review, allowing the program to move closer to achieving Strategic Goal 4.

On September 10, 2009, NASA and industry engineers lit up the Utah sky with the initial full-scale, full-duration test firing of the first stage motor for the Ares I rocket. ATK Space Systems, the prime contractor for the Ares I first stage, conducted the successful stationary firing of the five-segment solid Development Motor 1, or DM-1. Engineers will use the measurements gathered from the test to evaluate thrust, roll control, acoustics, and motor vibrations to help refine existing models that will be used to inform the design of future launch vehicles. Although similar to the solid rocket boosters that help power the Space Shuttle to orbit, the Ares development motor includes several upgrades and technology improvements.

The Ares I-X flight test is positioned to achieve its demonstration objectives in early FY 2010. From the development and deployment of the lightning protection system to the deployment of the program is positioned to conduct the test flight at the beginning of FY 2010.

For more about Constellation, go to www.nasa.gov/mission_pages/constellation/main/index.html.

Goal 5: Encourage the pursuit of appropriate partnerships with the emerging commercial space sector.

Responsible Mission Directorates: Exploration Systems and Space Operations

NASA's Commercial Crew and Cargo Program seeks to stimulate development of safe, reliable, and cost-effective space transportation capabilities within the emerging commercial space sector. The goal is to obtain crew and cargo launch options for our missions, a key part of achieving Strategic Goal 5, while encouraging growth and competition in the U.S. space industry. As part of the program, the Commercial



Credit: SpaceX

SpaceX's Falcon 9 launch vehicle sits on the pad at Cape Canaveral, Florida. The SpaceX team completed vehicle integration, preparing it for a test launch, on December 30, 2008. The COTS UHF CUCU radio transceiver, shown in the left photo, sits inside an electromagnetic interference test chamber.



Credit: SpaceX

Orbital Transportation Services (COTS) has funded Space Act Agreements with two partners, Space Exploration Technologies (SpaceX) and Orbital Sciences Corporation (Orbital).

Under the Cargo Resupply services contract, in December 2008, we awarded contracts to resupply the ISS utilizing newly developed vehicles capable of launching a spacecraft and cargo into low Earth orbit, and/or a spacecraft that can carry unpressurized or pressurized cargo and robotically dock with the ISS. Each contractor will provide a slightly different capability: The SpaceX vehicle will deliver pressurized cargo to the ISS and return pressurized cargo to Earth, while the Orbital vehicle will deliver pressurized cargo to the ISS and provide disposal capability, similar to the Russian Progress vehicles.

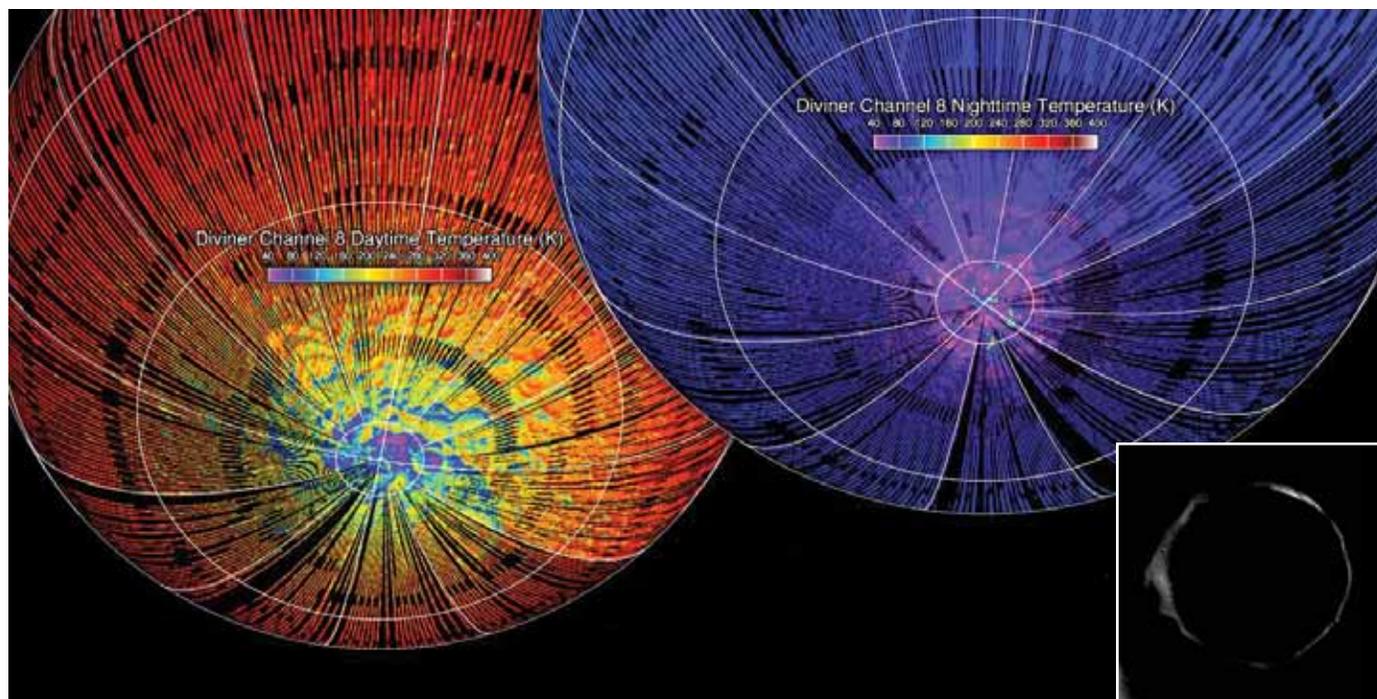
In preparation for their service to the ISS, SpaceX delivered the COTS Ultra High Frequency (UHF) Communication Unit (CUCU) to the Kennedy Space Center for launch on Atlantis STS-129 mission, scheduled for no earlier than November 16, 2009. ISS and Shuttle crewmembers will integrate the hardware with ISS systems in preparation for when the Dragon spacecraft docks. The UHF CUCU will provide communication between the ISS, SpaceX's Dragon spacecraft, and the ground systems. The unit allows crew at mission control and aboard the ISS to monitor the spacecraft's progress as it approaches the ISS and communicate with the spacecraft's navigation to adjust its course as it maneuvers to dock.

For more about the Commercial Crew and Cargo Program, go to www.nasa.gov/offices/c3po/home/index.html.

Goal 6: Establish a lunar return program having the maximum possible utility for later missions to Mars and other destinations.

Responsible Mission Directorates: Exploration Systems and Space Operations

The first step toward returning human explorers to the Moon is using robotic missions to gather information about potential landing sites and available resources. The LRO mission, launched with LCROSS on June 18, finished testing and calibration in September and began mapping the Moon's south pole from its orbit only 31 miles above the lunar surface.



Credit: NASA/JPL/UCLA

Credit: NASA/Arizona State University

The Moon's South Pole remains constantly cold, as shown in daytime (left) and nighttime temperature observations recorded by LRO's Diviner. Temperatures on the Moon are some of the most extreme in the solar system. Noontime surface temperatures near the lunar equator are hotter than boiling water, while nighttime surface temperatures are almost as cold as liquid oxygen. It has been estimated that near the lunar poles, in areas that never receive direct sunlight, temperatures can dip to within a few tens of degrees of absolute zero. Much of the interior of crater Erlanger (inset image), located in the south polar region, remains in permanent shadow providing an environment for cold trapping volatiles and will be a target of interest for LRO scientists.

In July, the LRO camera took high resolution photos of the Apollo landing sites. The images showed the lunar landers, experiment packages, and the footpaths left by the Apollo astronauts.

By mid-September, one of LRO's instruments, the Diviner Lunar Radiometer Experiment, had obtained enough data to characterize the Moon's current thermal environment. It measured extremely cold temperatures within the permanently shadowed regions of large polar impact craters, among the coldest temperatures measured for any body in the solar system, including Pluto.

For more on Exploration Systems programs, go to www.nasa.gov/exploration/home/index.html.

Other Agency Successes

Human Capital Management

The Office of Human Capital Management (OHCM) is implementing a new program called Early-Career Hiring Initiative to increase the number of people hired for entry-level and early-career positions. This program helps ensure a long sustainable workforce. These particular positions are filled with “fresh-outs,” or people who have completed bachelors, masters, or doctorate degrees less than three years ago. OHCM has authorized 173 positions for early-career engineers, scientists, and support personnel. As part of this effort to attract and retain fresh-outs, our Centers have begun initiatives such as the Dryden Flight Research Center's new professionals group to engage junior employees, the Langley Research Center's mentoring program designed to connect employees and foster career development, and the Goddard Space Flight Center's “Spacebook” (modeled after the popular Facebook social network site) to improve communication.

Inspiring Young and Diverse Scientists

The Office of Education works to build and strengthen a well-qualified and diverse future workforce for NASA and the Nation. However, Native Americans are an audience historically underserved and underrepresented in science, technology, engineering, and mathematics (STEM) college majors and careers. Traditional approaches for engaging students in STEM areas, like offering individual internships at our Centers or with aerospace partners, have not significantly increased interest among Native American students. This is due in part to differences in financial resources, family obligations, and culture. We have introduced a new approach that provides research opportunities enabling these students to interact with our scientists and technologies in ways that honor their culture, sidestep financial and relocation issues, and begin building the numbers of Native Americans working in STEM fields.

NASA's Minority University Research and Education Program piloted an “externship” as a new component to the Summer Research Experience activity for students and faculty of Tribal Colleges and Universities (TCUs). This twist on a classic internship brings NASA science and technologies to tribal college students rather than taking the students away from their home environment. The initial three weeks of the 10-week experience were conducted at United Tribes Technical College in North Dakota, a location within commuting for most of the participating students. The remaining seven weeks were spent conducting research at the students' home institution. This arrangement removed the burden of leaving their families. Twenty-one students and seven faculty representing nine TCUs participated in the externship pilot.

The externship was led by NASA scientists in collaboration with partners from the U.S. Geological Survey, the University of New Hampshire, and Tribal Scholars who provided Native American students and faculty members with training related to NASA Earth Science research. Participants received specialized training in the fundamentals of the scientific method,



Credit: United Tribes Technical College

A student in North Dakota collects samples of an invasive plant species as part of a hands-on project. Students presented their work to NASA scientists at one of several national meetings such as the Tribal College Forum. The opportunity to network with peers and professional role models is a known motivator for student performance and encourages them to pursue STEM careers. In the inset photo, as student stands with his poster presentation at the AIHEC National Conference.



Credit: United Tribes Technical College

indigenous knowledge, remote sensing, geospatial technologies, and climate change. The faculty and students used NASA tools and techniques, such as CanSat, Landsat and Lidar technologies, to conduct environmental and climate change research on their tribal lands, focusing on topics of local and cultural interest, such as drought, wetlands conservation, management of sacred lands, restoring habitats of indigenous plants, and controlling invasive species. Students who participated in the externship presented their work to NASA scientists at one of several national meetings such as the Tribal College Forum and the American Indian Higher Education Consortium (AIHEC) National Conference. The ability to network with peers and professional role models is a known motivator for student performance and pursuit of STEM careers.

Verification and Validation of NASA's Performance Data

We verify and validate our performance data to assure Congress and the public that reported performance information is credible. We have verified and validated that NASA's Mission Directorates and Mission Support Offices have established procedures for collecting, maintaining, and processing accurate GPRA performance data.

Each Mission Directorate and Mission Support Office has a process in place for assessing performance and assigning ratings to their Outcomes and APGs. NASA program officials enter supporting performance information into a secure Web-based system, which stores the information during and after the annual performance reporting process. Analysts within NASA's Office of Program Analysis and Evaluation (PA&E) conduct additional reviews and evaluations of reported performance data to assess whether the information submitted by the Mission Directorates and Mission Support Offices is consistent with information reported at other internal reviews and complete enough to portray an accurate picture of NASA's performance.

In FY 2009, PA&E surveyed the Mission Directorates and Mission Support Offices on their verification and validation procedures via the secure web-based system during the annual PAR data collection process. The survey required Mission Directorate and Mission Support Office officials to provide information about their processes for rating program performance, and maintaining and verifying data. PA&E analysts reviewed the survey results and conducted follow-up interviews during which officials provided documentation to prove the effectiveness and completeness of their performance information collection and storage processes. The PA&E analysts verified that each office has sufficient procedures in place to certify that their performance data is free of anomalies. This process enabled PA&E to capture snapshots of verification and validation processes across the Agency. PA&E will share best practices with the Mission Directorates and Mission Support Offices to improve their internal performance management systems.

Financial Results



This section analyzes and discusses NASA's Financial Statements and the Agency's stewardship of the resources provided to it by Congress to carry out its mission. The Financial Statements, which present the results of the Agency's operations and financial position, are the responsibility of NASA's management.

The Agency's financial statements and accompanying notes are presented in their entirety in the *Financials* section. NASA prepares the Consolidated Balance Sheet, Consolidated Statement of Net Cost, Consolidated Statement of Changes in Net Position and Combined Statement of Budgetary Resources statements, which provide the financial results of the Agency's operations. This overview focuses on the key information provided in the statements, which describes NASA's stewardship of the resources provided to it by Congress to carry out its mission.

Financial Highlights

Results of Operations

NASA's net cost of operations for FY 2009 was \$22.5 billion, an increase of \$4.1 billion, or twenty-two percent from FY 2008. Each of the Agency's Business Lines experienced an increase in net cost as the Agency emphasized programs essential to achieving various Strategic Goals.

NASA's programs and activities are carried out through four Business Lines: Aeronautics Research, Exploration Systems, Science, and Space Operations. The Consolidated Statement of Net Cost presents the Agency's net costs by Business Lines, which is summarized in the table on the next page. The net cost of operations is the gross (total) cost incurred by the Agency, less any earned revenue for work performed for other government organizations or for the public.

Space Operations, which includes the Shuttle and International Space Station programs, at \$10.6 billion, and Science, at \$6.0 billion, were the Agency's largest business lines in FY 2009. The accompanying table provides net cost comparisons for FY 2009 and FY 2008 across the Agency's four major business lines.

Cost by Business Line

(Dollars in Millions)

Line of Business	Unaudited 2009	Unaudited 2008	% Change
Aeronautics Research			
Gross Costs	\$ 828	\$ 779	6%
Less: Earned Revenue	113	86	31%
Net Costs	715	693	3%
Exploration Systems			
Gross Costs	5,153	4,811	7%
Less: Earned Revenue	33	28	18%
Net Costs	5,120	4,783	7%
Science			
Gross Costs	6,606	6,392	3%
Less: Earned Revenue	616	511	21%
Net Costs	5,990	5,881	2%
Space Operations			
Gross Costs	11,070	7,449	49%
Less: Earned Revenue	428	418	2%
Net Costs	10,642	7,031	51%
Net Cost of Operations			
Gross Costs	23,657	19,431	22%
Less: Earned Revenue	1,190	1,043	14%
Net Costs	\$ 22,467	\$ 18,388	22%

A significant portion of the increase in net costs relates to general costs for goods and services used in operations across all NASA programs, with the majority for the International Space Station (ISS). The remaining costs are allocated to all lines of business.

Aeronautics Research net costs increased \$22 million or three percent in FY 2009. Significant progress was made towards implementing the Next Generation Air Transportation System (NextGen), which is intended to yield revolutionary concepts, capabilities and technologies that will enable significant improvements in air traffic management.

Exploration Systems net costs were \$337 million or seven percent higher in FY 2009 primarily due to increased activity to develop the Orion Crew Exploration Vehicle as the next-generation, piloted spacecraft to bring into service after the planned Shuttle retirement in 2010, and the Ares I launch system and infrastructure to support the Nation's space exploration goals by the year 2015. In 2009, the Lunar Crater Observing and Sensing Satellite mission (LCROSS) launched the Lunar Centaur and Spacecraft to the Moon, impacting the lunar surface for the purpose of investigating the possible presence of water in a permanently shadowed crater.

Science net costs increased \$109 million or two percent in FY 2009. The Agency moved forward on several projects, including the Juno mission to conduct in-depth study of the planet Jupiter, which is scheduled to launch in 2011, and the Gravity Recovery and Interior Laboratory (GRAIL) project to determine the structure of the lunar interior and understanding of the evolution of the Moon. Components of Science costs decreased in 2009 with the transfer of the Deep Space Network (DSN) system, which enables continuous communication to spacecraft as the Earth rotates, from the Science line of business to the Space Operations line of business. Mars Science Laboratory operations stabilized, and 2009 costs were lower compared to 2008, as progress continued on the development of NASA's third-generation of rover to explore the red planet, which is scheduled for launch in 2011.

Space Operations net costs increased \$3.6 billion or fifty-one percent in FY 2009, primarily because of activities to complete the ISS. All Space Shuttle missions will be completed by the end of 2010, after which the Space Shuttle orbiters are scheduled to be retired. Spacecraft Operations completed activities to sustain engineering support and an increase in vehicle replacement spare parts, which will be essential once the Shuttle orbiters have been retired since there will not be return or repair capability. Space Operations also made significant progress on the Tracking and Data Relay Satellite (TDRS) Replenishment project to replenish the aging fleet of communications spacecraft in the space network.

Sources of Funding

NASA receives funds to support its operations primarily through Congressional appropriations. NASA's funds available for use in FY 2009 totaled \$21.3 billion, compared to \$20.9 billion in FY 2008, an increase of \$349 million. NASA's total budgetary resources come from various sources, as illustrated in the table below.

Available Budgetary Resources

(Dollars in Millions)

Line Item	Unaudited 2009	Unaudited 2008	% Change
New Budget Authority	\$ 18,786	\$ 17,373	8%
Unobligated Balance Brought Forward (Available)	814	2,402	-66%
Other Resources Available	1,696	1,172	45%
Total Available Resources	\$ 21,296	\$ 20,947	2%
Total Obligations Incurred	20,166	20,161	0%
Total Remaining Resources as of September 30	\$ 1,130	\$ 786	44%

New Budget Authority, which represented 88 percent of NASA's available resources in FY 2009, was provided by Congress primarily through two-year appropriations. New budget authority increased by eight percent, or \$1.4 billion, in FY 2009. This included \$1 billion in funding to NASA through the American Recovery and Reinvestment Act of 2009 (Recovery Act) to achieve the Space Program objectives listed in the table below. Details on NASA's progress are available at www.nasa.gov/recovery/index.html.

American Recovery and Reinvestment Act of 2009

(Dollars in Millions)

Operation	Funds Received	Objective
Cross Agency Support	\$50	<ul style="list-style-type: none"> To restore NASA-owned facilities damaged from hurricanes and other natural disasters occurring during calendar year 2008
Science	400	<ul style="list-style-type: none"> To accelerate the development of the Tier 1 set of Earth Science climate research missions recommended by the National Academies Decadal Survey To increase the Agency's supercomputing capabilities
Exploration Systems	400	<ul style="list-style-type: none"> To develop Constellation Systems to narrow the gap in U.S. human space flight capabilities between the 2010 retirement of the Space Shuttle and the 2015 launch of its replacement.
Aeronautics Research	150	<ul style="list-style-type: none"> To undertake systems-level research, development and demonstration activities related to: <ul style="list-style-type: none"> – Aviation safety – Environmental impact mitigation – The Next Generation Air Transportation System (NextGen)
Inspector General	2	<ul style="list-style-type: none"> To provide oversight of NASA's implementation and execution of the Recovery Act and the requirements of the Office of Management and Budget's implementing guidance
Total	\$1,002	

Unobligated Balance, Brought Forward represents budget resources remaining at the prior fiscal year-end that are available for use in the current fiscal year. Budget resources remaining at the end of FY 2009 that will be available for use in FY 2010 were \$1.1 billion and primarily represent Recovery Act funding (\$600 million) not yet obligated. Recovery Act funding was provided through two-year appropriations, and various initiatives are scheduled for completion in fiscal year 2010.

Other Resources includes funding received for sharing NASA technology and services provided to other Federal agencies and public entities, and recoveries of budget resources that were obligated in a previous year. Other Resources increased 45 percent in FY 2009 primarily for work performed for other government agencies, such as Department of Air Force for the Tracking and Data Relay System (TDRS), and the National Oceanic and Atmospheric Administration (NOAA) for the Polar Operational Environmental Satellites (POES) and Geostationery Operational Environmental Satellite (GOES) projects.

Obligations Incurred represents NASA's use of \$20.2 billion of available budget resources to accomplish the Agency's goals within its four Major Business Lines: Aeronautics Research, Exploration Systems, Science, and Space Operations. Obligations Incurred between FY 2009 and FY 2008 was relatively flat. Obligations Incurred represented a use of 95 percent of Total Available Resources in FY 2009, compared to 96 percent in FY 2008.

Balance Sheet

Assets

Total assets as of September 30, 2009 were \$23.7 billion, a decrease of \$3.6 billion compared to September 30, 2008. NASA's assets are divided into four categories, as described in the table below.

Agency Assets (Dollars in Millions)

Line Item	Unaudited 2009	Restated Unaudited 2008	% Change
Property, Plant, & Equipment	\$ 11,577	\$ 15,028	-23%
Fund Balance with Treasury	8,854	9,292	-5%
Inventory	3,019	2,883	5%
Other Assets	235	93	153%
Total Assets	\$ 23,685	\$ 27,296	-13%

NASA's largest category of assets is **Property, Plant & Equipment (PP&E)**, which decreased twenty-three percent, or \$3.5 billion, in FY 2009. Space Exploration PP&E represents 77 percent of total PP&E and consists mainly of assets supporting the ISS. In FY 2009 NASA prepared for the anticipated fiscal year 2010 application of Statement of Federal Financial Accounting Standards (SFFAS) 35, *Estimating the Historical Cost of General Property, Plant, and Equipment—Amending Statements of Federal Financial Accounting Standards 6 and 23*. As part of its preparation, NASA performed an analysis of the methodology used to account for the historical cost of ISS. Based on that analysis, the PP&E account balances for ISS were adjusted to reflect an estimated cost.

Fund Balance with Treasury (FBWT), which represents our cash balance at the Department of Treasury, decreased \$438 million. In addition to its normal appropriation, NASA received \$1 billion funding through the Recovery Act.

Inventory and Related Property, increased by \$136 million due to the completion of the external tanks to be used during Shuttle launches.

Other Assets includes Investments at \$17 million and Accounts Receivables at \$218 million in FY 2009. Accounts Receivable increased by \$142 million due to work performed for NOAA and the Department of the Air Force that was not collected as of September 30, 2009.

Liabilities

Total liabilities as of September 30, 2009, were \$4.1 billion, a decrease of \$99 million compared to September 30, 2008. The major categories of liabilities are detailed in the table below.

Agency Liabilities (Dollars in Millions)

Line Item	Unaudited 2009	Unaudited 2008	% Change
Accounts Payable	\$ 1,384	\$ 1,517	-9%
Other	1,786	1,724	4%
Environmental and Disposal Liabilities	922	943	-2%
Federal Employee and Veterans Benefits	57	64	-11%
Total Liabilities	\$ 4,149	\$ 4,248	-2%

Accounts Payable represents amounts owed for goods and services received that are due to other entities and accounted for the majority of the decrease in liabilities, \$133 million, relating to normal business operations.

Other Liabilities represents estimated contractor costs incurred but not yet paid, as well as contingent liabilities for litigation claims, accrued payroll and related costs and liability for advances and prepayments.

Environmental and Disposal Liabilities are estimated cleanup costs for actual or anticipated contamination from waste disposal methods, leaks, spills, and other NASA activity that created or could create a public health or environmental risk, and total cleanup costs associated with the removal, containment, and/or disposal of hazardous wastes or material and/or property that have been deferred until operation of associated PP&E ceases either permanently or temporarily. The estimate represents the amount that NASA expects to spend for the remediation of currently known contamination or for cleanup costs at the time an asset is removed from service. This estimate could change in the future due to the identification of additional contamination, inflation, deflation, or changes in technology or applicable laws and regulations. The estimate will also change through ordinary liquidation of these liabilities as cleanup programs progress.

Federal Employee and Veteran Benefits are amounts that NASA estimates for future worker's compensation liabilities for current employees. The estimate for future worker's compensation benefits includes the expected liability for death, disability, medical and miscellaneous costs for approved compensation cases, plus a component of incurred but not reported claims.

Net Position

Net Position represents the sum of Cumulative Results of Operations and Unexpended Appropriations. Net Position is the current value of the Agency's assets less its liabilities. The Agency Net Position decreased by \$3.5 billion.

Limitations of the Financial Statements

The principal financial statements have been prepared to report the financial position and results of operation of NASA, pursuant to the requirements of 31 U.S.C. 3515 (b). While the statements have been prepared from the books and records of NASA in accordance with Generally Accepted Accounting Principles (GAAP) for Federal entities and the formats prescribed by the Office of Management and Budget (OMB), the statements are in addition to the financial reports used to monitor and control budgetary resources, which are prepared from the same books and records.

The statements should be read with the realization that they are for a component of the U.S. Government, a sovereign entity.

Systems, Controls, and Legal Compliance



Management Assurances: Administrator's Statement of Assurance

November 16, 2009

NASA management is responsible for establishing and maintaining effective internal control and financial management systems that meet the objectives of the *Federal Managers' Financial Integrity Act* (FMFIA) as well as related laws and guidance. NASA is committed to a robust and comprehensive internal control program. We recognize that ensuring the effective, efficient, and responsible use of the resources that have been provided to the Agency is not only good stewardship, but also the right approach to maximizing our progress toward the realization of our goals. Within the Agency, I have made it clear that I am responsible for establishing and maintaining a sound system of internal control. In turn, I have made these responsibilities clear to my program management, Mission Support Offices, and Center management—and they have communicated this responsibility to their subordinates. As a result, managers and employees throughout the Agency are active on a daily basis in identifying or updating key control objectives, assessing risks, implementing controls or other mitigating strategies, conducting reviews, and taking corrective actions as necessary. In addition, NASA's basic governance structure—as represented by the Strategic Management Council, Program Management Council, and Operations Management Council—provides both the top-level guidance and the integration required to ensure our internal control program is operating effectively.

The Office of Internal Controls and Management Systems (OICMS) is the functional lead for NASA's internal control program, except for the internal controls over financial management and reporting, which are the responsibility of the Office of the Chief Financial Officer (OCFO), as further described below. During the past year, OICMS has taken significant steps to strengthen NASA's internal control program, focusing on improving the Statement of Assurance (SoA) self assessment process. OICMS developed and implemented the Internal Control Evaluation Tool (ICET), an internal control database management system. The ICET was used Agency-wide as an information system for each organization to complete and submit results of their internal control self assessment. The ICET has provided each NASA Headquarters (HQ) and Center organization with an information system to document programmatic and institutional key work activities, major risks, and primary controls to mitigate risk. Users evaluated results of self-assessments of the effectiveness of primary controls identified and rated the control effectiveness according to a red/yellow/green score.

The Fiscal Year (FY) 2009 SoA process also included a new acquisition assessment survey in response to a memorandum by the Office of Management and Budget (OMB) to provide guidelines for conducting internal control reviews of the acquisition function. An acquisition survey was developed and completed by senior management, program/project managers of major programs, and procurement officials to provide cross-cutting reviews of the acquisition process at NASA. In FY 2009, the OICMS also completed quality assurance reviews over the Statement of Assurance process for all HQ and Center organizations.

The OCFO establishes and maintains the internal controls over financial reporting and assesses and reports on the efficiency and effectiveness of those controls. The OCFO performs an annual review in compliance with OMB Circular A-123, Appendix A, *Internal Control Over Financial Reporting*, to support management's assertion on the

internal controls over financial reporting. The review entails an assessment of the design and operating effectiveness of key internal control activities for select business cycles, for safeguarding of assets, and for compliance with applicable laws and regulations. The OCFO follows a risk-based approach in determining the business cycles to be assessed during the current year, and each cycle is assessed at least once every three years. During FY 2009, the Agency's fund balance with Treasury, personal property, procurement and payment management, and revenue and receivables management cycles were assessed. In addition, the FY 2009 assessment focused on the operating effectiveness of the key controls of the accounts payable, accounts receivable, and fund balance with Treasury functions that transitioned to the NASA Shared Services Center. No new material weaknesses were identified as a result of the A-123-A work performed.

I am very pleased to report that the OCFO has implemented remedial actions necessary to resolve one of the two prior year material weaknesses. The successful remediation of the prior year material weakness in Financial Systems, Analyses, and Oversight resulted from improvements achieved through rigorous adherence to the Comprehensive Compliance Strategy, NASA's framework for ensuring compliance with Generally Accepted Accounting Principles and other financial requirements. These efforts included a more robust Continuous Monitoring Program over financial operations, progress toward substantial compliance with the *Federal Financial Management Improvement Act* (FFMIA), and resolution of intra-governmental issues with significant trading partners. While recognizing that this material weakness, outstanding for several years, has now been remediated, the OCFO will remain diligent in seeking ways to further improve financial management operations and Agency performance.

The Agency continued to make significant progress on NASA's one remaining material weakness—Controls over Legacy Property, Plant and Equipment (PP&E), related to valuation of legacy assets. The Agency believes it has now achieved compliance with the applicable updated accounting standard issued in October 2009 with respect to this class of assets. During FY 2009, the OCFO revised the estimated value of Legacy PP&E in anticipation of the pending release of the new accounting standard that allows estimating certain historical PP&E values reported in financial statements. While the Federal Accounting Standards Advisory Board (FASAB) has released Statement of Federal Financial Accounting Standards (SFFAS) 35, *Estimating the Historical Cost of General Property, Plant, and Equipment*, it was issued subsequent to the fiscal year end, and there was no provision for the retroactive application of the new standard. Although NASA was unable to demonstrate compliance under the prior standard for FY 2009, its Legacy PP&E valuation has been updated using alternatives under the new applicable standard.

With respect to the overall adequacy and effectiveness of internal control within the Agency, I hereby submit a qualified Statement of Assurance that NASA's internal controls and financial management systems meet the objectives of FMFIA, based on the fact that NASA's previously reported material weakness, Controls over Legacy PP&E, remained outstanding as of September 30, 2009. NASA also conducted its assessment of internal control over the effectiveness and efficiency of operations and compliance with laws and regulations in accordance with OMB Circular A-123, *Management's Responsibility for Internal Control*. I am pleased to report that no material weaknesses were identified during the past year's assessment of internal control over operations. Therefore, concerning the effectiveness of internal control over operations as of September 30, 2009, I am submitting an unqualified statement of assurance. However, due to the continuing material weakness in Controls over Legacy PP&E, I am submitting a qualified statement of assurance that the Agency's internal controls over financial reporting as of June 30, 2009, were operating effectively.

In accordance with the requirements of FFMIA, management is responsible for reporting on its implementation and maintenance of financial management systems that substantially comply with federal financial management systems requirements, applicable federal accounting standards, and the U.S. Government Standard General Ledger (SGL) at the transaction level. In FY 2009, NASA made significant progress toward substantial compliance with FFMIA. We use the Comprehensive Compliance Strategy and the Continuous Monitoring Program to ensure that financial management functions and activities are in compliance with Federal accounting standards, the U.S. SGL, and other applicable statutes, laws, regulations, and administrative guidelines. NASA's financial statements are prepared using information generated by the core financial system consistent with OMB Circular A-136, *Financial Reporting Requirements*, and the Agency's financial systems provide timely and reliable financial information. However, the Agency was unable to demonstrate substantial compliance with regard to (i) meeting some system access and change management controls, and (ii) fully integrating certain subsidiary systems, including some property systems, with the Agency's Core Financial Module. As a result, I consider NASA's financial management systems not substantially compliant with the requirements of FFMIA as of September 30, 2009.

As stated above, no new material weaknesses were identified, and one material weakness was resolved this past year. NASA will continue to work to ensure that its internal control program prevents new material weaknesses from developing. As required, we are also providing below a status report on the remaining material weakness, including progress made on corrective actions during the past year and planned actions for the coming year.

A handwritten signature in black ink, appearing to read 'C. Bolden, Jr.', with a long horizontal line extending to the right from the end of the signature.

Charles F. Bolden, Jr.
Administrator

NASA's Material Weaknesses and Non-Conformances

Remediation Program for Continuing Material Weaknesses

NASA continues to report Controls over Legacy Property, Plant and Equipment (PP&E) as a material weakness. NASA's estimation methodology for Legacy PP&E under the new Statement of Federal Financial Accounting Standards (SFFAS) 35, *Estimating the Historical Cost of General Property, Plant, and Equipment*, standard released by the Federal Accounting Standards Advisory Board (FASAB) October 14, 2009, will be evaluated in FY 2010. The prior year material weakness related to Financial, Systems Analyses, and Oversight has been resolved. The following chart shows NASA's prior year material weaknesses and significant remedial actions taken this fiscal year.

Controls Over Legacy Property, Plant & Equipment (PP&E)	
Material Weakness Description	The Financial Statement Auditor indicated . . . "Property, Plant & Equipment identified serious weaknesses in the design of the internal controls over the completeness and accuracy of legacy assets which prevented material misstatements from being detected and corrected in a timely manner by NASA. Certain legacy issues noted in prior-year audit reports continue to challenge the Agency, particularly in relation to the International Space Station (ISS) and Space Shuttles." (Agency Financial Report, PAR).
Significant Actions Taken in FY 2009	<p>During FY 2009, the OCFO revised the estimated value of Legacy PP&E in anticipation of the pending release of the new accounting standard SFFAS 35, <i>Estimating the Historical Cost of General Property, Plant, and Equipment</i> that allows estimating certain historical PP&E values reported in financial statements. While the FASAB has released SFFAS 35, it was issued subsequent to the fiscal year end, and there was no provision for the retroactive application of the new standard. NASA also:</p> <ul style="list-style-type: none"> Continued adherence to Capitalization Policy, NPR 9250.1, "Property, Plant and Equipment and Operating Materials and Supplies," effective October 1, 2007, and developed procedures to ensure that the identification of capital assets occurs at the time of acquisition. These procedures apply to new contracts and acquisitions beginning on or after October 1, 2007. Continued full integration of the Asset Accounting module within the core financial system to record, track, monitor and value NASA capitalized personal property; and Strengthened Continuous Monitoring Program (CMP) oversight of Property Plant & Equipment and implemented CMP Clinics to discuss exceptions, Center best practices, and provided real time training.
Anticipated Actions in FY 2010 and Beyond	NASA will continue to implement its capitalization policy on new PP&E and apply SFFAS 35 estimation methodology for its legacy PP&E.
Financial Systems Analyses and Oversight	
Material Weakness Description (Resolved)	NASA management and auditors identified weaknesses in the entity-wide internal control that impaired NASA's ability to report accurate financial information on a timely basis.
Significant Actions Taken in FY 2009	<p>In FY 2009 OCFO completed implementation of remediation actions necessary to resolve the Financial Systems, Analyses, and Oversight material weakness. The successful resolution resulted from improvements achieved through adherence to the Comprehensive Compliance Strategy (CCS), NASA's framework for ensuring compliance with generally accepted accounting principles and other financial requirements. These efforts include:</p> <ul style="list-style-type: none"> Implemented a more robust Continuous Monitoring Program (CMP) over financial activities. Made progress toward substantial compliance with the <i>Federal Financial Management Improvement Act</i> (FFMIA). Developed Environmental Liability estimate for decommissioning costs in compliance with SFFAS 6, <i>Property, Plant and Equipment</i>. Revised environmental liabilities estimating policy. Improved communication with Office of the General Council and Chief Financial Officer regarding contingencies. Coordinated with the Department of Treasury Intra-governmental Action Team to resolve Trading Partner differences.
Anticipated Actions in FY 2010 and Beyond	The Financial, Systems Analyses, and Oversight material weakness has been resolved and will no longer be reported. Although this prior year material weakness has been addressed, OCFO will continue the improvements implemented and monitor performance.

The Office of Inspector General's FY 2009 Management Challenges

NASA's Office of Inspector General (OIG), an independent entity, evaluates the programs and operations. The OIG submits an annual update of the most serious management challenges facing NASA.

We are committed to addressing these major management challenges. Using OIG's perspective as a catalyst, we will develop and implement the changes necessary to improve agency operations. Several key management challenges identified by the Office of the Inspector General are:

- Transitioning from the Space Shuttle to the Next Generation of Space Vehicles
- Managing Risk to People, Equipment, and Mission
- Financial Management
- Acquisition and Contracting Processes
- Information Technology Security

In FY 2010, the OIG will conduct work that focuses on efforts to meet these challenges as part of an overall mission to promote the economy and efficiency of the Agency.

The Government and Accountability Office's (GAO) High Risk List

NASA has been on the GAO High-Risk List in the area of Contract Management since 1990, when the first High-Risk List was published. In the most recent GAO update to the High-Risk List, issued in January 2009, GAO changed the title of this High-Risk item from Contract Management to Acquisition Management, acknowledging the broad scope of issues being addressed. As of January 2009, GAO noted that NASA has made a concerted effort to improve and has made important advances, but added that it will take several years for the Agency to fully implement its High-Risk initiatives.

The NASA initiatives are identified in a comprehensive Corrective Action Plan that meets Office of Management and Budget (OMB) requirements. Successful implementation of both the plan and revised policies should stem cost growth and schedule slippage. Additional information is available at www.nasa.gov/budget.

Looking Forward



NASA charged the Human Spaceflight Program Committee, chaired by Norman Augustine, with conducting an independent review of our current human spaceflight program and providing alternatives that would ensure that “the [N]ation is pursuing the best trajectory for the future of human spaceflight—one that is safe, innovative, affordable and sustainable.” The report provides the Nation and the Obama Administration with a thoughtful and comprehensive review of our past achievements and current path for exploring low Earth orbit and beyond.

As the Agency works with this Administration on how best to implement the far-reaching implications of the Augustine Committee Report, we must also stay focused on our near-term commitments.

Over the next year, the Space Shuttle will fly a series of missions that will complete its role in readying the International Space Station (ISS) for sustained operations. While its final mission is planned for the end of 2010, the Shuttle remains a recognizable symbol of U.S. engineering and scientific achievement, and its legacy will last far into the future. During the Space Shuttle’s lifetime, astronaut crews have used the Shuttle to deploy dozens of space and Earth science missions, and service spacecraft on orbit, including the Hubble Space Telescope, using its unique capabilities.

Through the past few Shuttle missions, the ISS life support capacity has been increased, and six people can now live and work on this unique facility. The expanded crew will continue to pursue the benefits of the ISS as an ongoing test bed for exploration technology development and demonstration, and continue developing the U.S. segment of the ISS as a national laboratory for use by other Federal entities and the private sector.

In science, several exciting new Earth Science missions will yield practical knowledge and innovative technologies for studying climate change and weather. Operation ICE Bridge, an airborne campaign, will measure changes in polar ice sheets to augment satellite observations of ice sheets in critical locations including Greenland, Antarctica, and Alaska. The launch of the GPM mission will improve ongoing efforts to predict climate, weather, and rainfall. Finally, the Global Hawk Unmanned Aerial Vehicle will begin collecting atmospheric data to add to NASA’s Earth Science analyses. Autonomous aircraft systems, like Global Hawk, are already improving and advancing hurricane monitoring techniques, and disaster support capabilities worldwide.

In aviation, as the number of flight operations at our Nation’s largest airports increases, noise and emissions present environmental concerns that limit the capacity of those airports, and in turn, the entire air transportation system. In an attempt to mitigate growing noise and emission concerns, a new program within NASA Aeronautics Research will begin to assess and demonstrate,



Credit: NASA

In past years the ISS could only accommodate extra crew as temporary visitors while a spacecraft was visiting. Now, with upgrades in place, the ISS is equipped to house six crewmembers. In this photo crewmembers share a meal near the galley in the Zvezda Service Module. Pictured from the left are NASA astronaut Michael Barratt, Expedition 19/20 flight engineer; European Space Agency astronaut Frank De Winne, Expedition 20 flight engineer and Expedition 21 commander; Russian cosmonaut Gennady Padalka, Expedition 19/20 commander; Canadian Space Agency astronaut Robert Thirsk, Expedition 20/21 flight engineer; and NASA astronaut Jeffrey Williams, Expedition 21 flight engineer and Expedition 22 commander; along with NASA astronaut Nicole Stott, Expedition 20/21 flight engineer.

at an integrated systems-level, promising concepts and technologies to enable a reduction in fuel consumption, as well as noise and local and global emissions to lessen harmful environmental impacts of the Nation's growing air transportation system.

As current and future work results in new capabilities, knowledge, and technologies, it is part of NASA's mission to share these advances with the Nation. Through this access, entrepreneurs, industry, academia, and other government agencies, are encouraged to innovate in ways that can help address national and global challenges, including increased interest for education in science and engineering fields, economic vitality, and stewardship of Earth.



Credit: NASA

NASA's P-3 aircraft flies over a frozen airfield in Thule, Alaska, as part of Operation ICE Bridge, a mission that is providing polar ice observations between ICESat I, which will end operations in 2009, and ICESat II, which is in formulation.



Detailed Performance



Measuring NASA's Performance



NASA creates an annual performance plan for each fiscal year to work toward achieving NASA's Strategic Goals. The performance plan includes multi-year Outcomes and Annual Performance Goals (APGs) under each Strategic Goal and Sub-goal included in NASA's Strategic Plan. This section provides detailed information on NASA's performance on the Agency's FY 2009 performance plan and the cost associated with those efforts.

NASA managers use both internal and external assessments to determine ratings for multi-year Outcomes and APGs. Internally, NASA monitors and analyzes each program's adherence to budgets, schedules, and key milestones. The managers provide these analyses during monthly/quarterly reviews at the Center, Mission Directorate, and Agency levels to communicate the health and performance of their programs and projects. Based on the ratings, the managers formulate appropriate follow-up actions.

External advisors, like the NASA Advisory Council, the National Research Council, and the Aerospace Safety Advisory Panel, assess program content and direction. Also, experts from the science community, coordinated by NASA's Science Mission Directorate, review the Agency's progress toward meeting performance measures under Sub-goals 3A through 3D.

Many of the programs and projects mentioned in NASA's performance measures are either robotic or human spaceflight missions. For more information on the missions mentioned in the PAR, please see NASA's Missions at a Glance, located in the *Other Accompanying Information* section of this document.

A Reader's Guide to NASA's Detailed Performance Data

NASA's detailed performance data is organized by the Strategic Goals and Sub-goals, to help the reader understand NASA's FY 2009 performance and the Agency's progress toward achieving each Strategic Goal and Sub-goal.

Summary of Performance

Each Strategic Goal or Sub-goal section presents a summary of performance ratings for the multi-year Outcomes and APGs that support the goal. It also provides the expenditures associated with those activities.

Benefits

This portion explains the value of work toward the Strategic Goal or Sub-goal, from gains within the Agency to benefits for academia, the public sector, and government.

Risks

Risk assessments are a regular part of NASA's review process. In this portion, NASA outlines and describes the primary concerns facing management with respect to cost, schedule, technical, or programmatic issues as they may affect individual missions, programs, or the Agency as a whole.

FY 2010 Performance Forecast

This list provides the reader with upcoming performance expectations.

Performance Measure Descriptions and Rating Trends

Each Outcome is a multi-year performance target designed to support the overarching Strategic Goal or Sub-goal. The description explains the activities completed in FY 2009 to meet the Outcome. NASA assigns ratings to

these Outcomes on a yearly basis, and provides the current rating along with previous years' ratings to show trends in performance. While NASA rates the Outcome on a yearly basis, the rating takes into account past performance and future work. Management uses the scale below to assign ratings to the Outcomes based on their internal and external assessment results.

Each APG is designed to support the multi-year Outcomes. Although the APG is annual, it may be repeated several years in a row. NASA assigns ratings to these APGs on a yearly basis, and provides the current rating along with previous years' ratings to show trends in performance. In some cases, an APG may support more than one Goal or Sub-goal, and will be shown multiple times. Management uses the scale below to assign ratings to APGs based on their internal and external assessment results.

What do the color ratings mean?		
Color	Multi-year Outcome Rating	Annual Performance Goal Rating
Green	NASA achieved most APGs under this Outcome and is on-track to achieve or exceed this Outcome.	NASA achieved this APG.
Yellow	NASA made significant progress toward this Outcome, however, the Agency may not achieve this Outcome as stated.	NASA failed to achieve this APG, but made significant progress and anticipates achieving it during the next fiscal year.
Red	NASA failed to achieve most of the APGs under this Outcome and does not expect to achieve this Outcome as stated.	NASA failed to achieve this APG and does not anticipate completing it within the next fiscal year.
White	This Outcome was canceled by management directive or is no longer applicable based on management changes to the APGs.	This APG was canceled by management directive and NASA is no longer pursuing activities relevant to this APG, or the program did not have activities relevant to the APG during the fiscal year.

Other Trending Information

If an APG is new in FY 2009, there will be no previous ratings available. The table below explains other trending information.

None	Although NASA may have conducted work in this area, management did not include a performance measure for this work in the fiscal year's performance plan.
6ESS11 Green	In prior years where data is available, NASA notes the applicable Outcome or APG reference number and rating to provide performance trends. In some cases, an APG may track to more than one performance measure in past performance years.
6ESS12 Green	

For any unmet performance measure in FY 2009, NASA managers are responsible for providing a reason for not achieving the measure and plans for reaching the measure in the future. The FY 2010 PAR will include an update to this year's Performance Improvement Plans, explaining activities and decisions that satisfy the plan set forth in FY 2009.

Additional Information

Uniform and Efficiency Measures

NASA uses Uniform and Efficiency Measures to track the performance of management areas such as cost, schedule, and project completion. A table provides these measures, with current and previous ratings for trending, organized by budget Theme.

FY 2008 Performance Plan Update

The FY 2008 Performance Improvement Plan Update reports activities and progress achieved during FY 2009 to resolve unmet measures from FY 2008.

Strategic Goal 1

Fly the Shuttle as safely as possible until its retirement, not later than 2010.



The Space Shuttle has supported NASA's Mission for nearly 30 years, carrying crews and cargo to low Earth orbit, performing repair, recovery, and maintenance missions on orbiting satellites, providing a platform for conducting science experiments, and supporting construction of the International Space Station (ISS). NASA plans to retire the Space Shuttle fleet when assembly of the ISS is complete. Until then, the Agency will demonstrate NASA's most critical value—safety—by promoting engineering excellence, maintaining realistic flight schedules, and fostering internal forums where mission risks and benefits can be discussed and analyzed freely.⁵

Benefits

The Space Shuttle is recognized around the world as a symbol of America's space program and the Nation's commitment to space exploration. NASA's Space Shuttle Program has inspired whole generations to pursue dreams and careers in science, technology, engineering, and mathematics. The program provides direct benefits to the Nation by advancing national security and economic interests in space, and by spurring technology development in critical areas such as navigation, computing, materials, and communications. Furthermore, due to its heavy-lift capacity, the Space Shuttle is the only vehicle capable of completing assembly of the ISS in a manner consistent with NASA's International Partner commitments and exploration research needs. The remaining Space Shuttle flights will be dedicated to ISS construction.

NASA will use the knowledge and assets developed over nearly three decades of Space Shuttle operations to build a new generation of vehicles designed for missions beyond low Earth orbit. As the Space Shuttle fleet approaches its retirement, the Agency gradually is directing available Space Shuttle personnel, assets,

and knowledge toward the development and support of new hardware and technologies that will support the development of new vehicles for exploration. For the American public, this means continuity in the access to space and sustained U.S. leadership in technology development and civilian space exploration.

Risks to Achieving Strategic Goal 1

The Space Shuttle Program faces two main challenges. First, NASA must maintain the skilled workforce and critical assets needed to safely complete the Space Shuttle manifest. Second, NASA must manage the process of retiring the Shuttle and transitioning or disposing of Space Shuttle assets and capabilities when they are no longer needed for safe mission execution of the Shuttle or Constellation programs.

The Space Shuttle transition and retirement effort is one of the largest that the Agency has undertaken in its history. As of the end of FY 2009, the Space Shuttle Program employed over 1,200 civil servants, with more than 11,000 work-year equivalents employed by prime contractors. The program's assets are significant; the program occupies over 640 facilities, and uses over 990,000 line items of hardware and equipment. The total equipment acquisition value is over \$12 billion, spread across hundreds of locations. The total facilities replacement cost is approximately \$5.7 billion, which accounts for approximately one-fourth of the value of the Agency's total facility inventory. The program has nearly 1,200 active suppliers located throughout the country.

Because of the size, complexity, and geographic dispersion of the program's assets, transition and retirement will require careful planning so as to not interfere with safe mission execution and not greatly impact other Agency activities. In addition to the sheer size of asset disposition activities, the Agency must cost-effectively manage and protect

⁵For more information on NASA missions, please see NASA's Missions at a Glance, located in the *Other Accompanying Information* section of this document.

the Space Shuttle capabilities needed to satisfy the Agency's Strategic Goal of flying out the manifest and completing assembly of the ISS. As ISS assembly is completed and the Space Shuttle Program's mission comes to a close, exploration development activities will continue to increase. Use of certain legacy capabilities can reduce the time and resources needed to achieve initial operational capability of the new designs. The program plays a key role in coordinating the smooth transition from current Space Shuttle operations to the next generation, thereby enabling new U.S. human spaceflight capabilities that will extend exploration and permanent human presence beyond low Earth orbit to the Moon, Mars, and beyond.

FY 2010 Performance Forecast

- NASA will safely complete assembly of the ISS with the last six flights planned for the Space Shuttle Program. Those missions will deliver the last of the U.S. pressurized elements to the ISS: Tranquility Node 3 and the Cupola (a seven-windowed module to be used as a control room for robotics). The missions will also deliver environmental control and life support equipment, hardware, and logistics needed to safely support and fully utilize the ISS once the Space Shuttle is retired.

- The Space Shuttle will deliver and install the Alpha Magnetic Spectrometer payload on the ISS during STS-134.

- Transition and retirement plans are in place or nearing completion for all Space Shuttle Program hardware elements, primary supporting Centers, and all organizations with a substantial role in ensuring a safe and efficient phase-out of Space Shuttle Program capabilities. The Space Shuttle Program and the Constellation Program already share some workforce, facilities, and operational experience. The number of shared capabilities will accelerate as they are no longer needed to support safe Space Shuttle Program completion.

- Finally, after 28 years, 134 missions, over 650 days of working in orbit, and over 500 million miles travelled in space, NASA will retire the Space Shuttle.



Credit: NASA

Astronaut Christopher Cassidy, STS-127 mission specialist, is visible in the lower right corner of this photograph, taken during the mission's third spacewalk of the flight. Cassidy is near the Japanese Experiment Module–Exposed Facility.

Outcome 1.1: Assure the safety and integrity of the Space Shuttle workforce, systems and processes, while flying the manifest.

The Space Shuttle safely and successfully completed every mission objective, including four crew rotations, for all five flights in FY 2009. Flight STS-126, launched in November 2008, delivered a Multi-Purpose Logistics Module loaded with hardware and supplies to support expansion of the ISS crew size from three to six. STS-126 also repaired the ISS's port Solar Alpha Rotary Joint (SARJ). The 10-foot-wide, wagon-wheel-shaped SARJ allows the electricity-generating solar arrays to track the sun and generate power for the Station. STS-119 launched in March 2009 and focused on the installation of the S-6 starboard truss, the last truss and solar array assembly for the ISS. STS-125 launched in May 2009 to perform the final servicing mission to the Hubble Space Telescope. In this mission, the crew successfully repaired two of Hubble's primary scientific instruments, replaced two other instruments with more advanced capabilities, attached a soft capture mechanism to facilitate eventual de-orbiting of the telescope, and refurbished the telescope's batteries, gyroscopes, guidance sensors, and thermal blankets. STS-127 launched in July 2009 to deliver and install the final pieces of the Japan Aerospace Exploration Agency's (JAXA) Kibo laboratory, including an external facility. The external facility will provide a way to expose science experiments to the extreme environment of space, an exposed experiment logistics module for storage, and some initial experiments. STS-128 launched in August 2009 to deliver hardware and logistics for future ISS assembly and research support.

FY06	FY07	FY08	FY 2009
Yellow	Green	Green	Green

FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
Achieve zero Type-A (damage to property at least \$1 million or death) or Type-B (damage to property at least \$250 thousand or permanent disability or hospitalization of three or more persons) mishaps in FY 2009.	6SSP1 Red	7SSP1 Green	8SSP01 Green	9SSP1 Green
Complete 100 percent of all mission objectives for all Space Shuttle missions in FY 2009 as specified in the Flight Requirements Document for each mission.	None	7SSP2 Green	8SSP02 Green	9SSP2 Green

Outcome 1.2: By September 30, 2010, retire the Space Shuttle.

NASA continues to prepare for the retirement of the Space Shuttle, once the Shuttle's role in assembling the ISS is complete. In FY 2009 the Space Shuttle Program transferred Mobile Launch Platform 1 and High Bay 3 in the Kennedy Space Center's Vehicle Assembly Building to the Constellation Program for the Ares I-X test flight. The program issued a Request for Information for final placement of the Space Shuttle Orbiters and Space Shuttle Main Engines after retirement. The program completed the final Space Shuttle Main Engine test at the Stennis Space Center, produced the final Main Engine, and continued production work on the last External Tank. The Space Shuttle Program released two Workforce Transition Strategy reports in FY 2009, and continues actively managing workforce reductions consistent with the reduction of Space Shuttle production capabilities.

FY06	FY07	FY08	FY 2009
None	Green	Green	Green

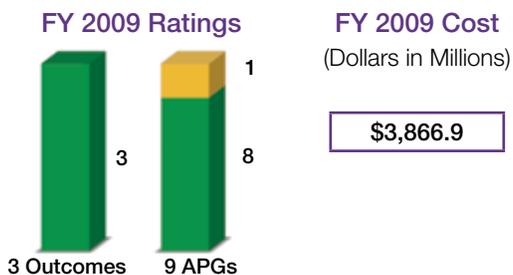
FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
A 13 percent reduction in Space Shuttle annual value of Shuttle production contracts for Orbiter, External Tank, Solid Rocket Boosters, Reusable Solid Rocket Motor, Space Shuttle Main Engine and Launch & Landing, while maintaining safe flight.	None	None	8SSP04 Yellow	9SSP3 Yellow
Reduce to twenty the number of dedicated Space Shuttle Kennedy Space Center (blocks of) facilities, while maintaining safe flight.	None	None	None	9SSP4 Green

Why NASA did not achieve APG 9SSP3: NASA maintained production capability to comply with the 2008 NASA Authorization Act, which directed NASA to not take any actions before April 30, 2009 that would preclude extending Shuttle flights beyond FY 2010. The current estimates also include additional production work due to STS-134, which was added to the manifest to launch and install the Alpha Magnetic Spectrometer.

Plans for achieving 9SSP3: Production of External Tank and Space Shuttle Main Engines is near completion, or completed. NASA will reduce other production contracts, when associated capabilities are no longer needed for safe completion of the Shuttle manifest.

Strategic Goal 2

Complete the International Space Station (ISS) in a manner consistent with NASA's International Partner commitments and the needs of human exploration.



Built and operated using state-of-the-art science and technology, the ISS—and by extension Strategic Goal 2—is a vital part of NASA's program of exploration. Through October 2009, there have been over 89 flights to the ISS, including flights for assembly, crew rotation, and logistical support. The ISS provides an environment for developing, testing, and validating next generation technologies and processes, which are needed to support Sub-goal 3F, Strategic Goal 4, and NASA's objective to return to the Moon and send human explorers deeper into space. When assembly is complete in 2010, the ISS will be composed of approximately 1,000,000 pounds of hardware brought to orbit over the course of more than a decade.⁶

Benefits

The ISS is a testbed for exploration technologies and processes. Its equipment and location provide a unique platform for Earth observations, microgravity research, and investigations into the long-term effects of the space environment on human beings. The ISS also enables research in fundamental physics and biology, materials sciences, and medicine. Crewmembers test processes for repairing equipment in microgravity, conducting spacewalks, and keeping systems operational over long periods of time. These capabilities are critical to future missions beyond low Earth orbit.

The ISS is the largest crewed spacecraft ever built. The ISS Program represents an unprecedented level of international cooperation with many nations providing the resources and technologies to build and keep the ISS operational. These international partnerships have increased cooperation and goodwill among participating nations. This partnership serves as a model for future space cooperation.

Risks to Achieving Strategic Goal 2

Strategic Goal 2 has three primary risks: the Space Shuttle Program's ability to complete the ISS manifest and complete assembly operations; the ISS Program's ability to acquire the necessary spares—small and large parts needed to keep ISS systems and equipment operational—to be launched on the Space Shuttle before the Shuttle fleet's retirement; and the continued operation of the systems that support the six-person crew capability.

FY 2010 Performance Forecast

- In FY 2010, NASA will complete the assembly of the ISS, having fulfilled its international partner agreements to launch and accommodate their modules. By the end of FY 2010, the ISS assembly and outfitting will be complete, and resupply by the Space Shuttle will end. The ISS today is a fully functioning laboratory in space, and when complete, the full force of its resources will be focused on utilization.

- Logistics supply will continue with STS-129, which will deliver the "Expedite the Processing of Experiments to Space Station" (ExPRESS) Logistics Carriers (ELCs) 1 and 2. The ELCs provide mechanical mounting surfaces, electrical power, and command and data handling services for science experiments.



Credit: NASA
The crew of the Space Shuttle *Endeavour* got this view of the ISS as the two spacecraft began their separation on July 28, 2009. Earlier, the STS-127 and Expedition 20 crews concluded 11 days of cooperative work onboard the Shuttle and ISS.

⁶For more information on NASA missions, please see NASA's Missions at a Glance, located in the *Other Accompanying Information* section of this document.

- NASA will launch the Cupola and Node 3 on STS-130. The Cupola is a European Space Agency-built observatory module that will provide a view of robotic operations, docked spacecraft, and Earth. Node 3, named Tranquility, will connect with the Cupola and will hold a new, advanced life support system.
- Logistics and resupply continues with STS-131, which will deliver the Multi-Purpose Logistics Module and the Lightweight Multi-Purpose Experiment Support Structure Carrier to the ISS.
- STS-132 will deliver the Russian Mini Research Module-1, a small research laboratory that will be attached to the Russian Zarya module.
- Flight STS-134 will deliver the Alpha Magnetic Spectrometer, a particle physics experiment that will be attached to the outside of the ISS and will search for evidence of dark matter and antimatter.

Outcome 2.1: By 2010, complete assembly of the U.S. On-orbit Segment; launch International Partner elements and sparing items required to be launched by the Shuttle; and provide on-orbit resources for research to support U.S. human space exploration.

NASA is on schedule to complete ISS assembly by 2010. NASA completed the truss and solar array assembly with the delivery of the S6 Solar Array on STS-119. NASA delivered two Japanese Exploration Agency (JAXA) elements that will complement each other to enhance research capabilities of the ISS: the Exposed Facility is a platform outside (i.e., exposed to the space environment) of the Japanese Kibo experiment module that will hold up to ten experiments at a time; the Experiment Logistics Module–Exposed Section is attached to the Exposed Facility, providing payload storage space and a logistic capability that will allow it to detach from the Exposed Facility and return to ground via the Space Shuttle.

FY06	FY07	FY08	FY 2009
Green	Green	Green	Green

FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
Based on the actual Space Shuttle flight rate, number of remaining Shuttle flights, and the discussions with the International Partners, update the agreed-to ISS assembly sequence and transportation plan as necessary.	None	7ISS1 Green	8ISS01 Green	9ISS1 Green
Accomplish a minimum of 90 percent of the on-orbit research objectives as established one month prior to a given increment.	6ISS3 Yellow	7ISS2 Green	8ISS02 Green	9ISS2 Green
Per the final configuration agreed to by the International Partners, fly the ISS elements and logistics baselined for FY 2009.	6ISS1 Green	7ISS3 Green	8ISS03 Green	9ISS3 Green
Provide increased ISS capability by assembling the remaining two Japanese Exploration Agency (JAXA) elements, the Exposed Facility (EF) and the Experiment Logistics Module-Exposed Section (ELM-ES), and the NASA EXPRESS Logistics Carriers (ELC) as baselined in FY 2009.	None	None	8ISS04 Green	9ISS4 Yellow

Why NASA did not achieve APG 9ISS4: NASA launched and assembled the elements of the Exposed Facility and the Experiment Logistics Module, except for the ELCs.

Plans for achieving 9ISS4: NASA plans to launch and install the ELCs in early FY 2010.

Outcome 2.2: By 2009, provide the on-orbit capability to support an ISS crew of six crewmembers.

In November 2008, the Space Shuttle delivered new hardware to the ISS to support expanding the ISS crew capacity from three to six:

FY06	FY07	FY08	FY 2009
None	Green	Green	Green

- The ISS crew previously depended on water delivered by the Space Shuttle or a cargo rocket. Since the delivery of the Water Recovery System Racks 1 and 2 in November, the ISS is able to produce about 6,000 pounds of potable water each year. The system works by using a filter that is designed to process the astronauts' urine and sweat into clean drinking water.
- A new Total Organic Carbon Analyzer will monitor key water quality parameters to ensure that the reclaimed water is safe for crew use.

- The crewmembers will be using the newly delivered Advanced Resistive Exercise Device as part of their exercise routine, which involves about 2.5 hours of physical exercise per day in order to mitigate the loss of muscle mass and muscular strength associated with long-duration exposure to microgravity.
- The Shuttle delivered additional living accommodations—a Waste and Hygiene Compartment, a galley (ExPRESS Rack #6), two crew quarters, and food warmers.

The three-person crew integrated and tested the new hardware, and with a Russian Soyuz spacecraft crew delivery, the ISS began six-crew operations on May 29, 2009.

FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
Install and make flight ready the following delivered ISS systems for six member crew capability in FY 2009: three crew quarters, Galley, Water Recovery System (WRS racks 1 and 2), second Treadmill with Vibration Isolation (TVIS2), and Waste Collection/Hygiene Compartment (WHC).	None	7ISS4 Green	8ISS05 Green	9ISS5 Green
In concert with the International Partners, assure a continuous crew presence on the ISS.	None	7ISS5 Green	8ISS06 Green	9ISS6 Green

Outcome 2.3: Conduct basic and applied biological and physical research to advance and sustain U.S. scientific expertise.

FY06	FY07	FY08	FY 2009
None	None	Green	Green

In FY 2009, NASA completed and launched exploration technology to the ISS, increasing the onboard research capabilities, capacity, accuracy, and safety. The Multi-User Droplet Combustion Apparatus (MDCA) was among the new equipment installed and enables experiments to assess the effectiveness of fire suppressants in microgravity. The Space Acceleration Measurement System (SAMS) for the Combustion Integrated Rack (CIR) will provide data about the vibrations caused by ISS hardware, and the information will be incorporated into results from vibration sensitive experiments conducted onboard. The Microgravity Science Glovebox (MSG) is an enclosed work area accessed by the scientists through gloveports, mitigating danger posed by experiments involving small parts, combustibles, gases or fluids. NASA launched the Light Microscopy Module (LMM), Constrained Vapor Bubble (CVB), and the SAMS for the Fluids Integrated Rack (FIR) on STS-128 on August 28, 2009.

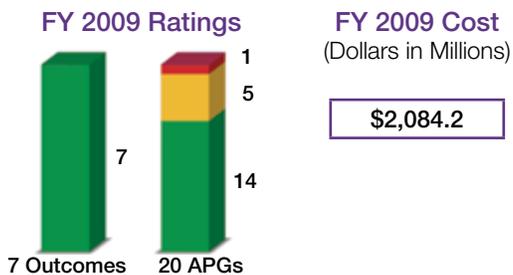
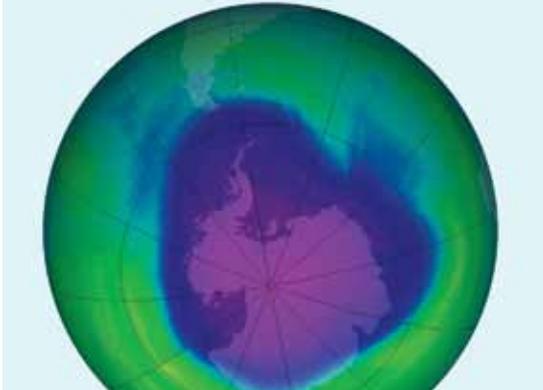
The crew continued to conduct research onboard the ISS. NASA completed three experiments on the ISS in FY 2009: Investigating the Structure of Paramagnetic Aggregates from Colloidal Emulsions-2 (InSPACE-2), Shear History Extensional Rheology Experiment (SHERE) and Smoke Point In Co-flow Experiment (SPICE). InSPACE-2 studied fluids that change properties in response to magnetic fields. Information gained from this experiment can be used to improve brake systems and robotic technology. More information about research and equipment on the ISS can be found summarized by experiment at www.nasa.gov/mission_pages/station/science/experiments/Expedition.html-21.

NASA selected nine investigators for Biospecimen sharing, as well as a principal investigator for the primary experiment. NASA was unable to secure a collaboration to fly experiments on an unmanned Russian spacecraft (Bion), which is used to conduct experiments in space biology. However, NASA was able to manifest a Shuttle flight to satisfy the same experimental goals.

FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
Deliver 3 out of 4 of the following exploration technology payloads to SOMD for launch to the ISS: Multi-User Droplet Combustion Apparatus, Light Microscopy Module/Constrained Vapor Bubble, Boiling Experiment Facility (BXF), Space Acceleration Measurement System accelerometers for CIR, FIR and BXF.	None	None	8AC01 Green	9AC1 Green
Complete the development of 3 out of 4 of the following non-exploration payloads: Investigating the Structure of Paramagnetic Aggregates from Colloidal Emulsions, Shear History Extensional Rheology Experiment, Advanced Plant Experiments on Orbit, Smoke Point in Coflow Experiment, Binary Critical Aggregation Test – 4.	None	None	None	9AC2 Green
Complete the selection of investigators for the BION (Russian collaboration) flight.	None	None	8AC02 Green	9AC3 Green

Sub-Goal 3A

Study Earth from space to advance scientific understanding and meet societal needs.



NASA's unique mission in Earth science, which is to expand human knowledge of the Earth through space activities, is specifically mandated by its establishing legislation, the National Aeronautics and Space Act of 1958. Indeed, half a century of progress in spaceflight and advances in space-related technology have steadily changed our perception of the Earth. Global satellite measurements of key characteristics have given rise to a profoundly new understanding of the Earth as a system of interconnected parts. NASA pioneered what is now called Earth System Science.

From the vantage point of space, NASA observes Earth system variability in multiple temporal and spatial scales, including at continental and planetary scales the vast extent and complexity of human activities. Over the past 50 years, world population has doubled, world grain supplies tripled, and total economic output grew sevenfold. NASA now observes that expanding human activities affect half the entire land surface of the Earth and are altering world atmospheric composition, oceans, ecosystems, and ice masses, as well. NASA has also observed how international agreements can begin to reverse some of those trends, as in the case of industrially produced chlorofluorocarbons.

Understanding these varying scale processes and their interaction enables predictive capability of the Earth system, quantitatively tested against satellite observations, to improve forecasting, and to inform resource management decisions and policies of governments at all levels. Thus, NASA's Strategic Sub-goal: "Study planet Earth from space to advance scientific understanding and meet societal needs" is expressed by the fundamental question: "How is the Earth changing and what are the consequences for life on Earth?"⁷

Benefits

Through the NASA Authorization Act of 2008, Congress identified several findings regarding science programs at NASA: "NASA should assume a leadership role in a cooperative international Earth observations and research effort to address key research issues associated with climate change and its impacts on the Earth system." In January 2007, the National Research Council (NRC) released its first Earth science decadal survey, *Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond*. This decadal survey describes Earth science as "one of the greatest intellectual challenges facing humanity" and outlines "a program of scientific discovery and development of applications that will enhance economic competitiveness, protect life and property, and assist in the stewardship of the planet for this and future generations." The NRC decadal survey spans priorities in Earth science for NASA, the National Oceanic and Atmospheric Administration (NOAA), and the U.S. Geological Survey (USGS). NASA has embarked on the implementation of the Decadal Survey recommendations, while continuing its critical contributions to national programs and interagency collaborations. For example, the NASA Earth Science program is the largest contributor to the Congressionally-mandated U.S. Global Change Research Program (USGCRP).

The Earth Science programs also help NASA achieve the Agency's other Strategic Goals and overall Mission:

- Earth-observing satellites provide meteorological information used by NASA, NOAA, and the Department of Defense (DoD) in providing weather forecasts that are used to fulfill their agency mandates.
- Measurement and analysis techniques, demonstrated first in Earth orbit and applied first to Earth studies, may help advance exploration and understanding of other planets in the solar system.

⁷For more information on NASA missions, please see NASA's Missions at a Glance, located in the *Other Accompanying Information* section of this document.

NASA and its partners—other government agencies, academia, non-profit organizations, industry, and international organizations—conduct vital research that helps the Nation manage environmental and agricultural resources and prepare for natural disasters. They create computer models that help predict climate change, storm paths, and earthquakes. In the course of conducting this research, NASA applies the resulting data and knowledge with the Agency’s operational partners to improve their decision-making in societal need areas such as public health, aviation, water management, air quality, and energy.

In FY 2009, Earth Science received \$325 million in American Recovery and Reinvestment Act funds to help the Agency complete critical projects or bolster underfunded programs.

Risks to Achieving Sub-goal 3A

Absence of a National Strategy for Earth Observation.

Acquisition of accurate, decadal-length, global time series of many different quantities is a necessary (although not sufficient) condition for achievement of sub-goal 3A. As noted in numerous National Research Council reports (including the Decadal Survey), these measurements must be obtained from a combination of NASA research missions and operational satellite systems operated by NOAA, DoD, and USGS. Inability by the operational agencies to transition NASA-demonstrated, research-quality measurements to the national operational satellite systems places at risk the required continuity of key time series. The National Polar-orbiting Operational Environmental Satellites System (NPOESS) co-funded by NOAA and DoD has recently been deemed by an independent review team to have a “low probability of success” as currently structured, and the NOAA Geostationary Environmental Operational Satellite (GOES)-R series has been de-scoped in response to budgetary pressure. Both the independent NPOESS review team and ongoing Office of Science and Technology Policy (OSTP)-led analyses aimed at revamping the NPOESS management and implementation approaches have concluded that the NASA NPOESS Preparatory Program research mission must be used to ensure the availability of basic meteorological measurements (historically provided by the civil and military operational environmental satellite systems) because of NPOESS delays and capability shortfalls, resulting in negative implications to the NASA research program. No stable funding and management paradigm is in place for the Landsat program within USGS. While NASA and NOAA have made progress in piloting the transition of ocean altimetry measurement, no similar progress has been made for the continued measurement of ocean vector winds by scatterometry, which has become a particular concern given the impending end of the mission based on instrument degradation taking place eight years after the end of QuikSCAT’s design life.

Unfunded Expansion of Program Scope. Actual and potential directed—but unfunded—expansion of the scope of the Earth Science Program is a risk to our ability to accomplish the established goals of the program and the ambitious guidance from the Decadal Survey. NASA technology development, research, and satellite missions have demonstrated the Agency’s ability to acquire high-quality spaceborne measurements and to advance science and applications through data analyses. The societal importance of many of our Earth observing capabilities is widely appreciated beyond the research communities. When urgent national needs for Earth observations arise unexpectedly or owing to launch vehicle failures or other-agency funding shortfalls, NASA Earth Science continues to be called upon to use funding from its baseline program to help fill those needs. Examples that could arise in the coming year include potential direction to implement a recovery copy for the OCO mission to support national carbon policy development and treaty/regulation monitoring, and development for future flight of the DSCOVR mission, which was not recommended as a Decadal Survey priority.



Credit: NASA/JPL-Caltech

NASA’s Eyes on the Earth 3D is a Web site that lets users view the latest data beamed back from NASA space satellites—in some cases, less than a few hours old (climate.nasa.gov/Eyes/index.html). Eyes on the Earth 3D displays the location of all of NASA’s 15 currently operating, Earth-observing missions in real time. These missions constantly monitor the planet’s vital signs, such as sea level height, concentration of carbon dioxide in the atmosphere, global temperatures, and extent of sea ice in the Arctic.

Return to Flight of the Taurus XL Launch Vehicle for Glory. The Glory research mission to make first-ever measurements of climatically important aerosol distributions and scattering properties is scheduled to launch in 2010 on a Taurus XL launch vehicle. The Taurus XL experienced a failure during the launch of the OCO spacecraft on February 24, 2009. The need to complete a successful return-to-flight process for the Taurus XL prior to the Glory launch introduces a schedule risk for Glory, and is likely to push the launch into the second quarter of FY 2011.

FY 2010 Performance Forecast

- Advance the use of uninhabited aerial systems (UASs) for Earth system science research, by utilizing them in multi-instrument and multi-platform field campaigns to study atmospheric composition and hurricanes.
- Aquarius—a mission to investigate the links between the global water cycle, ocean circulation, and climate—will progress toward launch readiness. The NASA-provided Aquarius instrument suite has been delivered to Argentina for observatory integration. The launch date will be subject to the progress of the International Partners in completion of instrument deliveries and observatory integration and test.
- Glory—which will study atmospheric conditions that influence climate and improve understanding of natural and man-made factors of climate change—will progress toward launch readiness. The launch date will be subject to completion of the return-to-flight process for the Taurus XL launch vehicle.
- GPM—which will focus on climate variability and change, water and energy cycles, and weather—will enter development with completion of its Confirmation Review.
- LDCM—which will continue the observations of the Landsat series of spacecraft—will enter development with completion of its Confirmation Review. The LDCM payload will include the TIRS instrument, which was added to this mission in response to 2009 Congressional direction to continue making thermal infrared measurements for observations of ground water.
- SMAP, the first Decadal Survey mission to begin formulation, will enter the Preliminary Design Phase. ICESat-II will enter into Formulation with the completion of its Key Decision Point (KDP)-A formulation review. The two other Tier 1 Decadal Survey missions, CLARREO and DESDynI, will conduct Mission Concept Reviews.
- Using funding provided by the American Recovery and Reinvestment Act of 2009, NASA has begun a new Airborne Science campaign, called Operation ICE Bridge, to bridge the gap between ICESat-I, which will end operations in 2009, and ICESat-II, which is not due to launch until about 2015. The campaign will use NASA's in-house and out-of-house aircraft and a variety of instruments to focus on changes in Greenland and arctic ice.
- Informed by a 2008 comparison study of seven Federal programs that incorporate Earth science data into decision-making activities for policy and management, the Applied Sciences Program will continue to leverage NASA Earth Science research and observations for practical use, such as resource management and planning, decision-making, and improved prediction and planning.

Outcome 3A.1: Progress in understanding and improving predictive capability for changes in the ozone layer, climate forcing, and air quality associated with changes in atmospheric composition.

New research released this year elaborated on the effects of different aerosol types, such as smoke particles, on clouds and precipitation. The research allows scientists to better quantify how much aerosols contribute to global climate changes. The burning of trees and plants in the savannas of southern Africa creates massive aerosol plumes that drift high above the ground. The aerosols—tiny suspended particles created by the fires—can reflect incoming solar radiation and create cooling or trap heat and warm the atmosphere. Researchers used data from the CALIPSO mission to show that the warming effect of aerosols increases with the amount of cloud cover below the aerosols. In fact, the researchers found the relationship between aerosol warming/cooling and the strength of cloud cover to be nearly linear, making it possible for them to define the critical amount of cloud cover at which aerosols switch from producing a cooling to a warming effect.

FY06	FY07	FY08	FY 2009
Green	Green	Green	Green

This newfound knowledge could improve long-term projections of global climate models that pull together many processes about the changing planet. More about this research is available at www.nasa.gov/topics/earth/features/calipso-aerosol.html.

NASA is working on two major foundational missions, Aquarius and Glory, which help the Agency achieve this Outcome and Outcome 3A.5. In June 2009, NASA delivered the Aquarius instrument suite to our partner, the Space Agency of Argentina (CONAE), for integration with their SAC-D spacecraft. NASA will also launch Aquarius. NASA engineers for the Glory project helped the contractor trouble-shoot and resolve technical challenges with the Aerosol Polarimetry Sensor (APS) instrument, and APS was delivered to Orbital Sciences Corporation on March 9 for integration with the Glory spacecraft. It is important to note that the Glory mission will be launched on a Taurus XL. This will be the first Taurus XL launch following the failure of the Orbiting Carbon Observatory (OCO) Taurus XL. The Glory launch is planned for late 2010, but this schedule will depend on the successful completion of the testing and design changes required to safely proceed with the next launch of the Taurus XL.

On February 24, 2009, the Taurus-XL launch vehicle failed to deliver the OCO spacecraft to orbit. OCO was a competitively selected, PI-led, experimental Earth System Science Pathfinder mission. The mission was intended to demonstrate for the first time the ability to make global space-based measurements of total-column atmospheric carbon dioxide concentrations with sufficient accuracy and quality to quantify distributed natural ocean-atmosphere and land-atmosphere carbon exchange processes and their roles in climate change. Had the experimental OCO technique proven successful as expected, the unique, accurate, near-surface carbon dioxide (CO₂) measurements obtained by the mission would have complemented and extended upper-atmosphere space-based CO₂ data sets being obtained from instruments on the NASA Aqua and Aura spacecraft and lower-quality, not-yet-validated measurements being acquired by the newly-launched Japanese GOSAT mission. The upper-atmosphere CO₂ data sets from Aqua and Aura, combined with NASA-funded analyses and modeling advances, continue to drive significant progress in NASA's study of Earth's environment and climate processes (specifically related to Outcomes 3A.1, 3A.3, and 3A.5); it had been hoped that addition of the high-quality OCO data stream would have enabled even greater, and more rapid, progress. Subsequent to NASA's 2002 selection of OCO for flight on the basis of its potential contributions to NASA Earth system science, the value of the OCO mission gained wider Administration, Congressional, and public appreciation owing to its potential contributions in the area of policy development, carbon monitoring, and treaty verification and enforcement (as documented in an unsolicited letter report from the National Academy of Sciences to Administrator Bolden on July 28, 2009, following the launch vehicle failure and subsequent loss of the OCO mission). As a result, there is great interest in the possibility of implementing a recovery copy of the mission. The OCO project team has been supporting NASA activities aimed at enabling the earliest possible implementation of an OCO-recovery mission, but NASA has not yet received direction from the Administration to initiate full development of such a recovery mission. Regarding the failure of the Taurus XL, NASA commissioned a Mishap Investigation Board which conducted a study of the vehicle failure, identified four potential causes, and made procedural recommendations to prevent future problems with the suspected launch vehicle hardware components. NASA's Space Operations Mission Directorate is developing plans for the return to flight of the Taurus XL to support the launch of Glory.

FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
Demonstrate progress in understanding and improving predictive capability for changes in the ozone layer, climate forcing, and air quality associated with changes in atmospheric composition (based on measurements from presently orbiting NASA and non-NASA assets). Progress will be evaluated by external expert review.	6ESS7 Green	7ESS1 Green	8ES01 Green	9ES1 Green
Develop missions in support of this Outcome, as demonstrated by completing the Orbiting Carbon Observatory (OCO) Launch Readiness Review (LRR).	None	7ESS6 Yellow	8ES04 Yellow	9ES2* Green
Develop missions in support of this Outcome, as demonstrated by completing the Glory mission Launch Readiness Review (LRR).	None	7ESS8 Yellow	8ES09 Yellow	9ES3 Red
Develop missions in support of this Outcome, as demonstrated by completing the integration and testing of the Aquarius instrument for delivery to the CONAE (Argentina) satellite observatory.	None	None	8ES10 Yellow	9ES4 Green
Develop mission in support of this Outcome, as demonstrated by completing the CLARREO advanced concepts study.	None	None	None	9ES5 Yellow
Conduct flight program in support of this Outcome as demonstrated by achieving mission success criteria for Aqua and CALIPSO.	None	None	None	9ES6 Green

*The OCO project successfully completed the observatory assembly, integration, and testing (including the Launch Readiness Review) ahead of schedule, conducted additional risk mitigation activities while waiting for the Launch Services Program to complete certification of the launch vehicle, and delivered OCO to the launch site for successful pre-launch activities. However, the Taurus launch vehicle fairing—the clamshell-like protective casing at the nose of the rocket that holds the payload during launch—failed to separate and release the OCO spacecraft during ascent, resulting in loss of the mission.

The OCO project successfully managed risks within their control and, if not for launch vehicle-associated delays, likely would have entered the operations phase ahead of schedule and under budget. Factors beyond those necessary to meet APG 9ES2 (i.e., the Taurus XL launch vehicle failure) were the reason that NASA did not achieve the intent of APG 9ES2.

Why NASA did not achieve APG 9ES3: NASA did not complete Glory’s Launch Readiness Review due to the failure of the OCO Taurus XL, in addition to issues with the vendor’s production of acceptable boards for the Maxwell Single Board Computers. Unfortunately, the team determined that the 24-layer circuit boards originally chosen for the project could not be reliably manufactured, and they are pursuing an alternate design. As a result of both issues, the project has delayed the Launch Readiness Date by 17 months.

Plans for achieving 9ES3: The project has switched to an alternate design for the circuit boards and is now working toward a Launch Readiness Review in November 2010. As mentioned above, the Glory launch date will be subject to the completion of the activities required to approve launch of the Taurus XL.

Why NASA did not achieve APG 9ES5: The date for the CLARREO Mission Concept Review was shifted to be consistent with the mission’s FY 2010 through FY 2012 funding profile.

Plans for achieving 9ES5: The Mission Concept Review, successful completion of which represents completion of the CLARREO advanced concepts study, is scheduled for mid-FY 2010.

3A.2: Progress in enabling improved predictive capability for weather and extreme weather events.

In the past year, NASA research produced new understanding of changes in precipitation patterns, especially those associated with tropical cyclones. New analysis of the past decade of data from Tropical Rainfall Measuring Mission (TRMM) has shown possible linkage between hurricane intensity and global warming. New analysis has also shown the possible impact of Saharan dust on Atlantic hurricanes. Based on this analysis, the inclusion of the Saharan air layer in global atmospheric models has shown improved forecasting of tropical cyclogenesis. Meanwhile, working with partners at NOAA weather forecast offices, measurements from NASA’s Atmospheric Infrared Sounder (AIRS), Lightning Mapping Array (LMA), and Moderate Resolution Imaging Spectroradiometer (MODIS) continue to improve the skills of operational weather forecasts.

FY06	FY07	FY08	FY 2009
Green	Green	Green	Green

The Aqua mission has been a resounding success in this area, and has set new standards for meteorological satellite systems. Many of the Aqua measurements are currently being relied upon in operational forecasting systems, as are the measurements of the QuikSCAT mission. QuikSCAT, which was launched with a two-year design life, recently completed its tenth year of operation, aiding in the prediction of the tracks of severe storms and hurricanes.

NASA researchers published results of an analysis using the Global Precipitation Climatology project (GPCP) merged satellite and surface conventional precipitation analysis and the Goddard Institute for Space Studies surface temperature analysis to compare trends in these two important fields. Global warming over the last 30 years is evident over most of the planet, although it is focused in northern high latitudes. However, any trends in precipitation are more varied, concentrated in the tropics, and more difficult to detect.

FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
Demonstrate progress in enabling improved predictive capability for weather and extreme weather events. Progress will be evaluated by external expert review.	6ESS7 Green	7ESS2 Green	8ES02 Green	9ES7 Green
Develop missions in support of this Outcome, as demonstrated by completing the Global Precipitation Mission (GPM) Confirmation Review.	None	None	8ES06 Yellow	8ES8 Yellow
Conduct flight program in support of this Outcome, as demonstrated by achieving mission success criteria for Aqua.	None	None	None	9ES9 Green

Why NASA did not achieve APG 9ES8: NASA did not complete the GPM Confirmation Review. NASA delayed the GPM confirmation review as a result of an incompatibility between the independent cost estimate developed by the Standing Review Board and the available budget. The project and the Science Mission Directorate have developed an approach and will present it to the Agency for approval at the Confirmation Review.

Plans for achieving 9ES8: The Confirmation Review is scheduled to be completed in December 2009.

3A.3: Progress in quantifying global land cover change and terrestrial and marine productivity, and in improving carbon cycle and ecosystem models.

In the past year, NASA research produced new understanding of changes in aquatic and terrestrial ecosystems and carbon dynamics. NASA and its partners acquired and released important new data products in this field. New analytical approaches for predicting biodiversity patterns enabled assessments of biodiversity during a time of biodiversity decline around the world, and may improve the understanding of the drivers behind biodiversity change. Strong progress was made toward understanding marine productivity through new analyses that revealed patterns of phytoplankton physiology over vast stretches of the ocean. NASA also made exciting advances in autonomous underwater vehicles and the vehicles' bio-optical observational capabilities have enabled researchers to validate data collected by satellites on biological and biogeochemical processes occurring in the ocean that ocean color satellite sensors can observe. Results from studies of new land uses in the tropics (e.g., expanding biofuel crop and rubber production) have quantified impacts on carbon emissions and potential climate changes. Results from the North American Carbon Program produced high-resolution, large-region estimates of carbon storage, demonstrating an advanced multi-scale approach.

FY06	FY07	FY08	FY 2009
Green	Green	Green	Green

Research into the carbon cycle is one of several areas of scientific investigation for which the loss of the OCO spacecraft will be felt. On the positive side, there has been significant progress in the development of sensor and mission capability in this arena. The LDCM spacecraft contract was awarded and the Thermal Infrared Spectrometer (TIRS) was added to the mission. The project, with this added scope, has completed Preliminary Design Review and confirmation, and is progressing well toward the Critical Design Review in 2010. The DESDynI mission is studying candidate mission concepts through its pre-Phase A study activities.

FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
Develop missions in support of this Outcome, as demonstrated by completing the Orbiting Carbon Observatory (OCO) Launch Readiness Review (LRR).	None	7ESS6 Yellow	8ES04 Yellow	9ES2* Green
Conduct flight program in support of this Outcome, as demonstrated by achieving mission success criteria for Aqua.	None	None	None	9ES9 Green
Demonstrate progress in quantifying global land cover change and terrestrial and marine productivity, and in improving carbon cycle and ecosystem models. Progress will be evaluated by external expert review.	6ESS7 Green	7ESS3 Green	8ES03 Green	9ES10 Green
Develop missions in support of this Outcome, as demonstrated by completing the Landsat Data Continuity Mission (LDCM) Critical Design Review (CDR).	None	None	None	9ES11 Yellow
Develop missions in support of this Outcome, as demonstrated by completing the DESDynI advanced concept study.	None	None	None	9ES12 Yellow

*The OCO project successfully completed the observatory assembly, integration, and testing (including the Launch Readiness Review) ahead of schedule, conducted additional risk mitigation activities while waiting for the Launch Services Program to complete certification of the launch vehicle, and delivered OCO to the launch site for successful pre-launch activities. However, the Taurus launch vehicle fairing—the clamshell-like protective casing at the nose of the rocket that holds the payload during launch—failed to separate and release the OCO spacecraft during ascent, resulting in loss of the mission.

The OCO project successfully managed risks within their control and, if not for launch vehicle-associated delays, likely would have entered the operations phase ahead of schedule and under budget. Factors beyond those necessary to meet APG 9ES2 (i.e., the Taurus XL launch vehicle failure) were the reason that NASA did not achieve the intent of APG 9ES2.

Why NASA did not achieve APG 9ES11: NASA did not complete the LDCM CDR in FY 2009. At Initial Confirmation Review, the Standing Review Board recommended that LDCM's launch readiness date, which was seen as being too aggressive, be changed. The CDR was rescheduled accordingly.

Plans for achieving 9ES11: The LDCM CDR is currently scheduled for mid-FY 2010.

Why NASA did not achieve APG 9ES12: The date for the DESDynI Mission Concept Review was shifted to be consistent with the mission's FY 2010 through FY 2012 funding profile.

Plans for achieving 9ES12: The Mission Concept Review, successful completion of which represents completion of the DESDynI advanced concepts study, is scheduled for mid-FY 2010.

3A.4: Progress in quantifying the key reservoirs and fluxes in the global water cycle and in improving models of water cycle change and fresh water availability.

NASA-sponsored research using satellite observations has improved and created new estimates of water cycle variables, both fluxes and reservoirs, including their relationship with other important environmental processes. MODIS data from the Terra and Aqua satellites has been used in multiple ways to better understand snow and in-land water dynamics, especially the climate change-affected regions of the northern latitudes. In particular, new analyses assisted by decades of Landsat images revealed that the number of inland lakes in the northern areas of Canada and Russia have orders of magnitude larger than previously suspected. Comparable studies have also shown that annual fluxes of water into and out of these regions are higher than previously expected due to the large number of ephemeral lakes that are responsible for snowmelt capture. Additional satellite data from Aqua (the AMSR-E instrument) and QuikScat have been combined with MODIS to better assess snow melt timing and dynamics. Multiple satellite data streams and hydrologic models have been used to better understand agriculture areas and drought dynamics. Satellite data has also been used to better understand and estimate the movement of water in the atmosphere, with particular emphasis on the water flux from the world's oceans. Reaching the tenth anniversary of the TRMM satellite, the Global Precipitation Climatology Project released a number of global precipitation data sets, including the TRMM Composite Climatology (TCC), which is a combination of selected TRMM rainfall products over both land and ocean. In many cases, these advances represent a strong contribution towards improving climate model representation of water cycle attributes. Finally, significant advances were made in techniques evaluating re-analysis and other climate model output. The Goddard Space Flight Center team of scientists initiated the release of Modern Era Retrospective-Analysis for Research and Applications (MERRA), for the first time incorporating numerous satellite data products into a recent climate model depicting the water and energy cycle.

FY06	FY07	FY08	FY 2009
Yellow	Green	Green	Green

FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
Develop missions in support of this Outcome, as demonstrated by completing the Global Precipitation Mission (GPM) Confirmation Review.	None	None	8ES06 Yellow	9ES8 Yellow
Conduct flight program in support of this Outcome, as demonstrated by achieving mission success criteria for Aqua.	None	None	None	9ES9 Green
Demonstrate progress in quantifying the key reservoirs and fluxes in the global water cycle and in improving models of water cycle change and fresh water availability. Progress will be evaluated by external expert review.	6ESS7 Green	7ESS5 Green	8ES05 Green	9ES13 Green
Develop missions in support of this Outcome, as demonstrated by completing the SMAP advanced concepts study.	None	None	None	9ES14 Green

Why NASA did not achieve APG 9ES8: NASA did not complete the GPM Confirmation Review. NASA delayed the GPM confirmation review as a result of incompatibility between the independent cost estimate developed by the Standing Review Board and the available budget. An approach has been developed and will be presented for Agency approval at the Confirmation Review.

Plans for achieving 9ES8: The Confirmation Review is scheduled to be completed in December 2009.

3A.5: Progress in understanding the role of oceans, atmosphere, and ice in the climate system and in improving predictive capability for its future evolution.

There has been notable progress in observations and modeling with respect to understanding the role of ocean, atmosphere and ice in the climate system. First, NASA has extended the global sea level record from altimetry and examined its regional variations. The combination of the sea level record with in-situ ocean density profiles and GRACE measurements of ice mass variation are beginning to reconcile the individual contributing elements of the observed global sea level rise. Globally-averaged sea level continues to rise at a rate of approximately three millimeters per year averaged between 1992 and 2008, significantly above the approximately 1.7 millimeters per year seen in the 20th Century, indicating acceleration in sea level rise. Sixteen years of global satellite observations of sea surface topography from Jason-2 (Ocean Surface Topography Mission), Jason-1 and TOPEX/POSEIDON made it possible, together with data from in-situ sensors.

FY06	FY07	FY08	FY 2009
Yellow	Yellow	Yellow	Green

Second, the joint analysis of wind and sea surface temperature measurements from NASA satellites is shedding new light on air-sea interaction and surface flux estimates. Furthermore the decade long record of winds from QuikSCAT is being carefully analyzed for climate trends. Practical utilization of this and other data in climate models has been considerably enhanced over the last year by work on advanced data assimilation techniques and development of fully coupled models (coupling ocean with the atmosphere and sea ice). The predictability of an El Niño Southern Oscillation (ENSO) ‘warm event’ was extended several months ahead of what was previously possible, a finding with both scientific and socio-economic consequences of great importance. High-resolution, long-term climatologies of ocean surface vector winds from QuikSCAT made it possible.

Satellites have only been monitoring sea ice since 1973, but their contribution to researchers’ understanding of the relationship between sea ice extent and the climate system is invaluable. This year scientists at the Goddard Space Flight Center analyzed data from ICESat-1, published in the journal *Nature*, indicating that ice loss in Antarctica and Greenland is more extensive and pervasive than previously thought. Thinning is occurring at outlet glaciers all around Greenland, even the northernmost glaciers, and tapping the deep interior in isolated places. Antarctic glaciers are thinning rapidly in coastal areas, some losing almost 30 feet per year in the period 2003 to 2007. NASA’s Earth Observatory Antarctic Sea Ice Web site (earthobservatory.nasa.gov/Features/WorldOfChange/sea_ice_south.php) provides a year-by-year visual comparison of the sea ice September maximum (the end of the Antarctic winter) and February minimum beginning in September 1999 and ending in February 2009. Taken by NASA and partner Earth observation satellites, the images show the long-term decline in the sea ice in the Bellingshausen and Amundsen Seas.

FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
Develop missions in support of this Outcome, as demonstrated by completing the Orbiting Carbon Observatory (OCO) Launch Readiness Review (LRR).	None	7ESS6 Yellow	8ES04 Yellow	9ES2* Green
Develop missions in support of this Outcome, as demonstrated by completing the Glory mission Launch Readiness Review (LRR).	None	7ESS8 Yellow	8ES09 Yellow	9ES3 Red
Develop missions in support of this Outcome, as demonstrated by completing the integration and testing of the Aquarius instrument for delivery to the CONAE (Argentina) satellite observatory.	None	None	8ES10 Yellow	9ES4 Green
Conduct flight program in support of this Outcome as demonstrated by achieving mission success criteria for Aqua and CALIPSO.	None	None	None	9ES6 Green
Demonstrate progress in understanding the role of oceans, atmosphere, and ice in the climate system and in improving predictive capability for its future evolution. Progress will be evaluated by external expert review.	6ESS7 Green	7ESS7 Green	8ES07 Green	9ES15 Green
Develop mission in support of this Outcome, as demonstrated by completing the ICESat II advanced concepts study.	None	None	None	9ES16 Yellow

*The OCO project successfully completed the observatory assembly, integration, and testing (including the Launch Readiness Review) ahead of schedule, conducted additional risk mitigation activities while waiting for the Launch Services Program to complete certification of the launch vehicle, and delivered OCO to the launch site for successful pre-launch activities. However, the Taurus launch vehicle fairing—the clamshell-like protective casing at the nose of the rocket that holds the payload during launch—failed to separate and release the OCO spacecraft during ascent, resulting in loss of the mission.

The OCO project successfully managed risks within their control and, if not for launch vehicle-associated delays, likely would have entered the operations phase ahead of schedule and under budget. Factors beyond those necessary to meet APG 9ES2 (i.e., the Taurus XL launch vehicle failure) were the reason that NASA did not achieve the intent of APG 9ES2.

Why NASA did not achieve APG 9ES3: NASA did not complete Glory’s Launch Readiness Review due to the failure of the OCO Taurus XL, in addition to issues with the vendor’s production of acceptable boards for the Maxwell Single Board Computers. Unfortunately, the team determined that the 24-layer circuit boards originally chosen for the project could not be reliably manufactured, and they are pursuing an alternate design. As a result of both issues, the project has delayed the Launch Readiness Date by 17 months.

Plans for achieving 9ES3: The project has switched to an alternate design for the circuit boards and is now working toward a Launch Readiness Review in November 2010. As mentioned above, the Glory launch date will be subject to the completion of the activities required to approve launch of the Taurus XL.

Why NASA did not achieve APG 9ES16: NASA did not complete the ICESat-2 Mission Concept Review, which represents successful completion of the advanced concepts study.

Plans for achieving 9ES16: The February 2009 Mission Concept Review demonstrated inadequate reconciliation of science requirements and mission cost. During the following eight months, the mission implementation approach was refined to meet science objectives within mission cost. The Delta-Mission Concept Review was completed successfully on November 3, 2009.

3A.6: Progress in characterizing and understanding Earth surface changes and variability of Earth's gravitational and magnetic fields.

The twin GRACE satellites have spent more than seven years mapping Earth's gravity fields, revealing changes due to surface and deep currents in the ocean, runoff and ground water storage on land masses, exchanges between ice sheets or glaciers and the oceans, and variations of mass within Earth. Over the past year, researchers used the GRACE mission's sensitivity to slight gravitational changes to help researchers in northern India figure out if their vital underground water supply was drying up. The researchers analyzed six years of monthly GRACE data for northern India to produce a time series of water storage changes beneath the region's land surface. The data showed that staggering population growth and extensive irrigation is extracting groundwater at rates that are not sustainable. The research also showed the value of this sort of Earth observation. Now researchers can study and monitor water use on land with no additional ground-based data collection, which is important in developing countries where water-use data are both sparse and hard to access. More on this story is available at www.nasa.gov/topics/earth/features/india_water.html.

FY06	FY07	FY08	FY 2009
Green	Green	Green	Green

Earth's crust is constantly moving, sometimes producing movements too small for humans to notice and other times creating devastating earthquakes, landslides, or other events. By studying Earth surface changes, NASA researchers hope to predict hazardous events and aid mitigation or disaster response. Since its delivery in late 2008, NASA conducted test flights of the Uninhabited Aerial Vehicle Synthetic Aperture Radar (UAVSAR), an all-weather, high-precision radar for mapping crustal deformations. As the UAVSAR—a 10-foot-long pod attached to the belly of NASA's modified Gulfstream III jet—flies over a site, it takes images beneath Earth's surface. An autopilot function allows it to repeatedly fly over the same areas within a 15-foot margin of error. This allows it to take three-dimensional imaging of strain along faults, the inflation of volcanoes prior to eruption, and the deformation of Earth's surface related to landslides, fluid withdrawal, and sink-holes. During the summer, NASA flew tests faults in the San Francisco Bay Area, central California and southern California, and the Los Angeles Basin. After testing, NASA will transfer the UAVSAR to an unmanned aerial vehicle.

FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
Conduct flight program in support of this Outcome, as demonstrated by achieving mission success criteria for Aqua.	None	None	None	9ES9 Green
Develop missions in support of this Outcome, as demonstrated by completing the Landsat Data Continuity Mission (LDCM) Critical Design Review (CDR).	None	None	None	9ES11 Yellow
Develop missions in support of this Outcome, as demonstrated by completing the DESDynI advanced concept study.	None	None	None	9ES12 Yellow
Demonstrate progress in characterizing and understanding Earth surface changes and variability of Earth's gravitational and magnetic fields. Progress will be evaluated by external expert review.	6ESS7 Green	7ESS10 Green	8ES11 Green	9ES17 Green

Why NASA did not achieve APG 9ES11: NASA did not complete the LDCM CDR in FY 2009. At the Initial Confirmation Review, the Standing Review Board recommended that LDCM's Launch Readiness Date, which they saw as being too aggressive, be changed. The CDR was rescheduled accordingly.

Plans for achieving 9ES11: The LDCM CDR is currently scheduled for mid-FY 2010.

Why NASA did not achieve APG 9ES12: The date for the DESDynI Mission Concept Review was shifted to be consistent with the mission's FY 2010 through FY 2012 funding profile.

Plans for achieving 9ES12: The Mission Concept Review, successful completion of which represents completion of the DESDynI advanced concepts study, is scheduled for mid-FY 2010.

3A.7: Progress in expanding and accelerating the realization of societal benefits from Earth system science.

In FY 2009, the program's SERVIR (Spanish for "to serve") Regional Monitoring and Visualization System project continued its record of accomplishment. The project uses a satellite visualization system to provide real-time environmental monitoring in Central America and Africa. NASA established a SERVIR Program Office in 2008 to ensure that NASA can continue to support USAID, and this office was key in 2009 to the continued expansion of this invaluable tool to other developing regions over the next few years. For more information on SERVIR, visit www.nasa.gov/mission_pages/servir/index.html.

FY06	FY07	FY08	FY 2009
Green	Green	Green	Green

For a third year, NASA's Wildfire Research and Applications Partnership (WRAP) project, together with the Ikhana unmanned aerial vehicle, supported the state of California in managing and fighting wildfires in California. For more information on WRAP, visit geo.arc.nasa.gov/sge/WRAP/.

The program has also made significant achievements in other areas that benefit society. The Centers for Disease Control (CDC) launched a new National Environmental Public Health Tracking Network. NASA played a key role in developing this network by developing data products and algorithms for tracking and projecting health problems related to air pollution.

FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
Issue twelve reports with partnering organizations that validate that using NASA research capabilities (e.g., observations and/or forecast products) could improve their operational decision support systems.	None	7ESS11 Green	8ES12 Green	9ES18 Green
Increase the number of distinct users of NASA data and services.	6ESS5 Green	None	8ES13 Green	9ES19 Green
Maintain a high level of customer satisfaction, as measured by exceeding the most recently available federal government average rating of the Customer Satisfaction Index.	6ESS6 Yellow	None	8ES14 Green	9ES20 Green

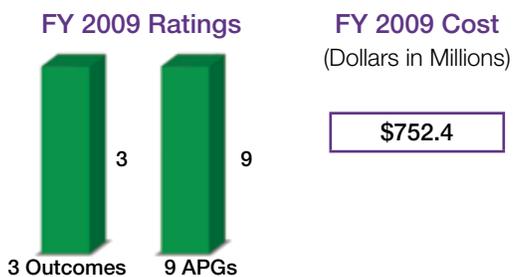
Sub-Goal 3B

Understand the Sun and its effect on Earth and the solar system.



Life on Earth is linked to the behavior of the Sun. The Sun's energy output is fairly constant, yet its spectrum and charged particle output are highly variable on numerous timescales. Moreover, short-term events like solar flares and coronal mass ejections can change drastically solar emissions over the course of a single second. The solar system's planets orbit within the outer layers of the Sun's atmosphere, and some of the planetary bodies, like Earth, have an atmosphere and magnetic field that interacts with the solar wind. While Earth's magnetic field protects life, it also acts as a battery, storing energy from solar wind until it is released, modifying "space weather" that can disrupt communications, navigation, and power grids, damage satellites, and threaten the health of astronauts.

To achieve Sub-goal 3B, Heliophysics Theme researchers study the Sun and its influence on the solar system as elements of a single, interconnected Earth-Sun system. A group of spacecraft that form an extended network of sensors allows researchers to investigate the magnetic Sun and its effect on the planets and the solar system. Using data from these spacecraft, NASA seeks to understand the fundamental physics behind Sun-planet interactions and study space environmental hazards.⁸



Benefits

Recent years have witnessed the growing national importance of space weather and its economic and societal effects. Space weather affects radio and radar propagation through the ionosphere, induces errors to GPS-derived position coordinates, endangers astronauts, spacecraft, and high-altitude aircraft, substantially modifies the ozone layer and, for extreme solar cycle shifts, has the potential to induce climate variations. Society is increasingly dependent on technologies that are vulnerable to space weather

events. The prediction of solar events and mitigation of their effects is important to the public safety and the Nation's economy and security.

Equally important, our local space environment provides a convenient venue for studying at close hand the plasmas that make up most of the visible universe. Under the control of magnetic fields, plasmas organize into galactic jets, radio filaments, supernova bubbles, accretion disks, galactic winds, stellar winds, stellar coronas, sunspots, heliospheres, magnetospheres, and radiation belts. Studies of our local space environment provide knowledge relevant to remote astrophysical plasma systems that are inaccessible to direct study.

Risks to Achieving Sub-Goal 3B

Of primary concern for the Heliophysics Division is the increase in cost, and the reduction of Expendable Launch Vehicle (ELV) options. Over the course of the last decade, the Delta II has been the workhorse for the Science Mission Directorate (SMD), its loss leaving only costlier evolved ELVs (e.g., Delta IV, Atlas V) for many of the missions identified in the NASA Science Plan, or much smaller launch vehicles with insufficient capability. NASA is aggressively exploring options to maintain a vital Heliophysics flight program, including alternate launch providers for mid-range payloads.

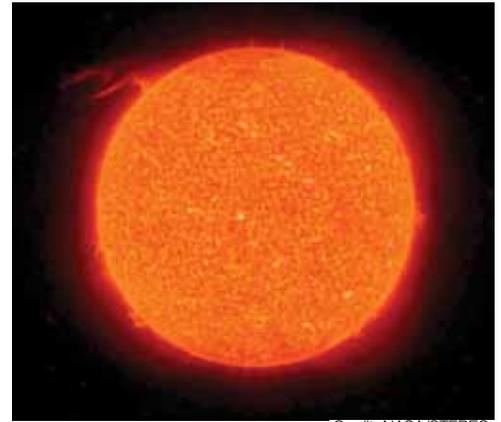
One of the key capabilities of the Heliophysics program is the coordination of its many spacecraft to observe the interacting system as a whole. Recently several Heliophysics spacecraft have ceased operation after long mission lives, or lost critical instruments after their prime science phase. While well beyond their operational lifetimes, the loss of these observatories/instruments means that critical measurements with which to gain knowledge about the end-to-end Sun to Earth connection are now not available. Some of these capabilities will be replaced and improved

⁸For more information on NASA missions, please see NASA's Missions at a Glance, located in the *Other Accompanying Information* section of this document.

upon by future missions, but these will not be launched for a number of years. This is of rising concern because of the potential to impede the scientific advances needed to understand our extended space environment and provide the capability to predict space weather.

FY 2010 Performance Forecast

- The Research and Analysis Program will hold its annual competition for new research awards.
- NASA will continue to operate the 16 Heliophysics missions and conduct a Senior Review of these missions. Heliophysics data centers will continue to archive and distribute collected science data. The annual Guest Investigator competition will be held to support and extend the scientific impact of these missions.
- The Sounding Rockets Program will launch approximately 15 payloads from domestic and international locations.
- Science Data and Computing Technology will hold its annual competition for the Applied Information Systems Research Program.
- NASA will launch and commission the SDO spacecraft. SDO will image the Sun to study variations in solar irradiance that influence Earth's climate, how the solar magnetic field is structured and how its energy is converted and released into the heliosphere in the forms of solar wind and energetic particles.
- Heliophysics will complete its Critical Design Review (CDR) of the MMS mission by the end of FY 2010. MMS is a four-spacecraft mission to study magnetic reconnection in key boundary regions of Earth's magnetosphere, providing better understanding of this primary process by which energy is transferred from the solar wind to Earth's magnetosphere.
- Heliophysics will complete its CDR of the RBSP mission early in FY 2010. RBSP is a two-spacecraft mission to investigate how populations of relativistic electrons and ions in space are formed or changed in response to the variable inputs of energy from the Sun.
- Heliophysics will solicit instruments for the Solar Probe mission via the Announcement of Opportunity process. Approaching as close as 8.5 solar radii above the Sun's surface, the Solar Probe will employ a combination of in-situ measurements and imaging to achieve the mission's primary scientific goal: to understand how the Sun's corona is heated and how the solar wind is accelerated.
- Heliophysics will complete the Mission Design Review (MDR) for the IRIS mission recently selected for the Explorer Program. IRIS will trace the flow of energy and plasma through a dynamic solar interface region, the chromosphere and transition region, which lies between the solar surface and the solar corona.



Credit: NASA/STEREO

The Sun had no sunspots for 51 days in a row from July 11 through August 30, 2009—nearly breaking the record (52 days) for the longest quiet period of this solar cycle set last summer. As researchers watched 50 days of that period with STEREO in extreme UV light, they saw some activity like prominences popping up, but no active regions strong enough to form a sunspot. On August 31, a little sunspot emerged (not shown in the photo) to interrupt the long string of quiet days. Nevertheless, it is likely that the current year's number of blank days will be the longest in about 100 years.

Outcome 3B.1: Progress in understanding the fundamental physical processes of the space environment from the Sun to Earth, to other planets, and beyond to the interstellar medium.

Several of NASA's Heliophysics missions provided important new insights this year into energetic particle acceleration mechanisms in a number of different space physics regimes. This new knowledge will help explain the fundamental processes that generate high-energy particles in solar flares, interplanetary shocks, Earth's radiation belts, the aurorae (i.e., Northern and Southern Lights), and by extension, astrophysics.

FY06	FY07	FY08	FY 2009
Green	Green	Green	Green

RHESSI imaged for the first time gamma ray flare sources high in the solar atmosphere. This imaging shows the origin of the highest energy photons associated with solar flares, providing indications of the elusive location of the particle acceleration process itself. STEREO made the first unequivocal detection of energetic neutral hydrogen

from solar flares. These neutral atoms, thought to originate in solar flares, travel from the Sun quickly without being deflected by the Sun's magnetic fields, yielding important information about the timing of particle acceleration in flares.

Several NASA missions provided new insight on the removal process of dust from the solar system through dust-plasma interactions. The STEREO spacecraft revealed that the smallest dust grains move away from the Sun at extreme speeds. These nanoparticles move at speeds approaching a million miles-per-hour. Nanoparticles are electrically charged by sunlight and are so lightweight that the solar wind magnetic field picks them up and rapidly transports the particles away from the Sun. Such dust constantly bombards Earth's atmosphere, generating meteoritic smoke. Observed by the AIM mission and by the Mesospheric Aerosol Sampling Spectrometer suborbital sounding rocket, it is believed that this meteoritic smoke plays a role in high-altitude ozone-hole chemistry and cloud formation.

Understanding how the outer atmospheres of the Sun and other stars are heated to multi-million degree temperatures is one of the cornerstone problems of space science. Hinode X-Ray Telescope observations confirmed that magnetic reconnection is a driving force behind many classes of solar eruptive events (e.g., solar flares, coronal mass ejections, and X-ray jets). Impulsive energy release from magnetic reconnection is found to be important, not only in large-scale eruptions, but also in the acceleration of solar wind and the heating of the solar corona. The combination of Hinode's magnetic field measurements, extreme ultraviolet spectroscopic and X-ray imaging data provided the first complete picture of the interaction of the Sun's photospheric magnetic field with the overlying corona, providing the description of how energy is released and particles are energized. Hinode showed that coronal heating takes the form of small impulsive energy bursts called nanoflares, exactly as predicted by theoretical models.

Significant progress has also been made in understanding the timing and spatial structure of near-Earth releases of stored magnetic energy from the solar wind. These explosive energy releases, called magnetic storms and substorms, send currents and energetic particles into Earth's upper atmosphere, causing communication and power system disruptions. They also inject energetic particle fluxes to geosynchronous orbit, where they endanger the health of orbiting spacecraft.

FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
Demonstrate progress in understanding the fundamental physical processes of the space environment from the Sun to Earth, to other planets, and beyond to the interstellar medium. Progress will be evaluated by external expert review.	6ESS11 Green	7ESS13 Green	8HE01 Green	9HE1 Green
	6ESS12 Green			
	6ESS14 Green			
	6ESS15 Green			
Develop missions in support of this Outcome, as demonstrated by completing the Magnetospheric Multiscale (MMS) Spacecraft Preliminary Design Review (PDR).	None	7ESS15 Red	8HE02 Green	9HE2 Green
Develop missions in support of this Outcome, as demonstrated by completing the Geospace Radiation Belt Storm Probes Confirmation Review.	6ESS18 Green	7ESS16 Green	8HE04 Green	9HE3 Green
Develop missions in support of this Outcome, as demonstrated by completing the Explorer down-select.	None	None	None	9HE4 Green
Conduct flight program in support of this outcome, as demonstrated by achieving mission success criteria for STEREO, AIM, THEMIS and IBEX.	None	None	None	9HE5 Green

Outcome 3B.2: Progress in understanding how human society, technological systems, and the habitability of planets are affected by solar variability and planetary magnetic fields.

The transition region between Earth's upper atmosphere and the space environment is a critical boundary in the Sun–Earth system. NASA is making significant advances in understanding this boundary by studying the ways in which it couples to regions above and below it, as well as within itself. The AIM mission provided major advances in understanding polar mesospheric clouds (PMCs), the highest clouds in Earth's atmosphere. PMCs have been becoming brighter and more frequent since their discovery in the late 1800s. It is important to understand these trends because of the possible relationship between these clouds

FY06	FY07	FY08	FY 2009
Green	Green	Green	Green

and global warming. AIM data show a connection between polar clouds present in the summer mesosphere and increased stratospheric wind speeds in the winter mesosphere. PMC occurrence is sharply seasonally dependent: transitioning in May from no clouds to 100 percent occurrence within a matter of days and then reversing that trend at the season end in August.

In addition, AIM has made the first global measurements of meteoric smoke particles in Earth's upper atmosphere. These particles are important to understanding a variety of phenomena including mesospheric ion and neutral chemistry, nucleation of polar stratospheric clouds, and the accumulation of extraterrestrial material in polar ice. There is also new information on the relationship between PMCs and atmospheric waves: observations have shown that upward-propagating waves produce transient and localized heating at higher altitudes that in turn leads to ice sublimation and hence dimmer PMCs. NASA made remarkable progress in identifying and understanding these processes, leading to a greater appreciation of the centrality of coupling in the upper atmosphere boundary region.

Through a new analysis technique researchers applied data from the European Space Agency (ESA)/NASA Cluster mission to quantify the amount of hydrogen escaping each year from Earth's atmosphere. Thousands of tons of hydrogen are flowing out of Earth's atmosphere every day. While this rate means that Earth is in no danger of losing its atmosphere for several more billion years, Earth is losing more of its atmosphere per day than Venus and Mars, which have negligible magnetic fields. Understanding why the Venus, Mars, and Earth atmospheres behave differently when initially the planets were similar will help determine the history and likely fate of Earth's atmosphere.

Multi-satellite missions such as THEMIS and Cluster have shown that many particles of solar origin gain entry to Earth through its magnetic shield. During intervals when the Interplanetary Magnetic Field (IMF) is oriented northward, reconnection can occur nearly simultaneously above the northern and southern poles, trapping particles in a thick layer. Twenty times more particles cross Earth's shield at this time compared to intervals of southward IMF. The newly trapped particles flow into either the northern or southern cusp and then into the plasma sheet in the magnetotail. Processes within the magnetosphere subsequently energize the particles causing geomagnetic storms. The significance of the discovery lies in the fact that it provides the information needed to determine when most solar wind particles enter the magnetosphere, the first step towards developing a predictive model for the storms.

FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
Develop missions in support of this Outcome, as demonstrated by completing the Magnetospheric Multiscale (MMS) Spacecraft Preliminary Design Review (PDR).	None	7ESS15 Red	8HE02 Green	9HE2 Green
Develop missions in support of this Outcome, as demonstrated by completing the Geospace Radiation Belt Storm Probes Confirmation Review.	6ESS18 Green	7ESS16 Green	8HE04 Green	9HE3 Green
Develop missions in support of this Outcome, as demonstrated by completing the Explorer down-select.	None	None	None	9HE4 Green
Demonstrate progress in understanding how human society, technological systems, and the habitability of planets are affected by solar variability and planetary magnetic fields. Progress will be evaluated by external expert review.	6ESS10 Green	7ESS19 Green	8HE03 Green	9HE6 Green
	6ESS13 Green			
Conduct flight program in support of this Outcome, as demonstrated by achieving mission success criteria for AIM and THEMIS.	None	None	None	9HE7 Green

Outcome 3B.3: Progress in developing the capability to predict the extreme and dynamic conditions in space in order to maximize the safety and productivity of human and robotic explorers.

TRACE and SOHO observations of coronal mass ejections (CMEs) are providing key insights into the origins, propagation, and consequences of the solar events that are most effective in producing magnetic storms at Earth. The data have revealed the importance between the emergence and structure of electric currents within the solar atmosphere, their relationship to the surrounding magnetic field, and the ability to forecast CMEs. The twin STEREO spacecraft have provided scientists with their first view of the true speed, trajectory, and shape of CMEs. This new capability is dramatically enhancing scientists' ability to predict if and how these solar tsunamis affect Earth, and improving the forecasting accuracy of storm arrivals at Earth from the current 12 hours to just two or three hours.

FY06	FY07	FY08	FY 2009
Green	Green	Green	Green

The Sun has a strong 11-year cycle related to variations in its magnetic activity. No solar cycle is exactly the same as another, however, and recent observations indicate that sunspot activity during this 2007–2009 minimum is surprisingly low as compared to cycles of the last century. This has a major impact on models predicting solar activity, and for understanding the underlying physics of the sunspot cycle. In the last few years, the Sun has set the following records:

- A 50-year low in solar wind pressure and magnetic field at the poles: Measurements by the Ulysses spacecraft reveal a 35-percent drop in solar wind polar magnetic field strength, and a 20-percent drop in solar wind pressure since the solar minimum of 1996. This is important because the solar wind shields the inner solar system from galactic cosmic rays and a weaker solar wind also means fewer geomagnetic storms and auroras on Earth.
- A long-term low in solar irradiance: Measurements by several NASA spacecraft show that the sun’s brightness has dropped by 0.02 percent at visible wavelengths and six percent at extreme ultraviolet wavelengths since the solar minimum of 1996. The changes are not enough to affect the course of global warming, but Earth’s upper atmosphere is significantly less heated and therefore less expanded. Satellites in low Earth orbit experience less atmospheric drag and space junk remains longer in orbit.
- A 55-year low in solar radio emissions: Radio telescopes are recording the dimmest radio emissions from the sun since 1955. Some researchers believe that the lessening of radio emissions is an additional indication of weakness in the Sun’s global magnetic field.

FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
Develop missions in support of this Outcome, as demonstrated by completing the Geospace Radiation Belt Storm Probes Confirmation Review.	6ESS18 Green	7ESS16 Green	8HE04 Green	9HE3 Green
Demonstrate progress in developing the capability to predict the extreme and dynamic conditions in space in order to maximize the safety and productivity of human and robotic explorers. Progress will be evaluated by external expert review.	6ESS8 Green	7ESS20 Green	8HE05 Green	9HE8 Green
	6ESS9 Green			
Conduct flight program in support of this Outcome, as demonstrated by achieving mission success criteria for STEREO.	None	None	None	9HE9 Green

Sub-Goal 3C

Advance scientific knowledge of the solar system, search for evidence of life, and prepare for human exploration.



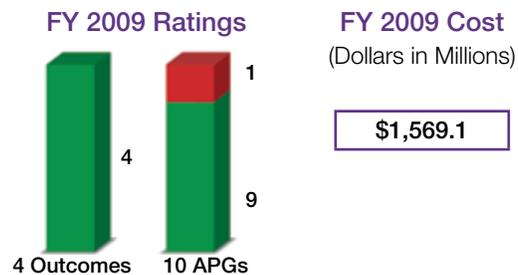
To achieve Sub-goal 3C, the Planetary Science Theme uses robotic science missions to investigate alien and extreme environments throughout the solar system. These missions help scientists understand how the planets of the solar system formed, what triggered the evolutionary paths that formed rocky terrestrial planets, gas giants, and small, icy bodies, and the origin, evolution, and habitability of terrestrial bodies. The data from these missions guide scientists in the search for life and its precursors beyond Earth and provide information to help NASA plan future human missions into the solar system.⁹

Benefits

NASA's robotic science missions are paving the way for understanding the origin and evolution of the solar system and to identify past and present habitable locations. With this knowledge, NASA is potentially enabling human space exploration by studying and characterizing alien environments and identifying possible resources that will enable safe and effective human missions to the Moon and beyond.

Robotic explorers gather data to help scientists understand how the planets formed, what triggered different evolutionary paths among planets, and how Earth formed, evolved, and became habitable. To search for evidence of life beyond Earth, scientists use this data to map zones of habitability, study the chemistry of alien worlds, and unveil the processes that lead to conditions necessary for life.

Through the Near Earth Object Observation Program, NASA identifies and categorizes asteroids and comets that come near Earth. Every day, a hundred tons of interplanetary particles drift down to Earth's surface, mostly in the form of dust particles.



Approximately every 100 years, rocky or iron asteroids larger than 164 feet in diameter crash to Earth, causing damage like craters and tidal waves, and about every few hundred thousand years, an asteroid larger than a kilometer threatens Earth. In the extremely unlikely event that such a large object threatens to collide with Earth, NASA's goal is to provide an early identification of these hazardous objects as far in advance (perhaps years) as possible.

Risks to Achieving Sub-goal 3C

Of primary concern for Planetary Science is the reduction in Expendable Launch Vehicle (ELV) options. Over the course of the last decade, the Delta II has been the workhorse for the Science Mission Directorate (SMD). Its loss leaves only larger and costlier evolved ELVs (e.g., the Delta IV and Atlas V) for many of the missions identified in the NASA Science Plan or much smaller launch vehicles with significantly reduced capabilities for missions such as those in the Discovery or New Frontiers Program. NASA is aggressively exploring options to maintain a vital flight program, including the development of dual payload launch capability and alternate launch providers for mid-range planetary payloads.

MSL has suffered a launch slip to October or November 2011. The funding for this delay has largely affected activities within the Mars Exploration Program such as the Mars technology and future mission concept developments. Impacts to non-Mars programs have been kept to a minimum without the need for a delay or cancellation of approved missions now under development. However, if significant additional funding is needed to overcome persistent technical problems, other missions in development may be delayed.

⁹For more information on NASA missions, please see NASA's Missions at a Glance, located in the *Other Accompanying Information* section of this document.

FY 2010 Performance Forecast

- The Research and Analysis Program will continue to release research announcements and make selections.
- The Planetary Data System will continue to archive and release planetary science data to the science community in a timely manner for further scientific analysis.
- The Astromaterial Curation project will continue its efforts on curation and distribution of solar system samples returned by NASA planetary missions.
- The New Frontiers program will select mission concepts for Phase A studies in FY 2010.
- The Rosetta project will support the fly-by of Asteroid Lutetia (November 2010), and Hayabusa will continue to provide navigation, deep-space network tracking, and science analysis support to JAXA to support an Earth return in 2010.
- The Near Earth Objects Observations (NEOO) Program will continue to detect impact hazards to the Earth.
- The Lunar Quest Program project, LADEE, will enter Implementation Phase in FY 2010.
- The MESSENGER spacecraft will begin preparations for its Mercury orbit insertion in 2011, while it continues its operations and return of valuable data from three fly-bys.
- The Dawn spacecraft will be cruising from a Mars gravity assist in February 2009 in preparation for its Vesta encounter in 2011.
- GRAIL will complete its Critical Design Review in early FY 2010 and plans to begin Assembly, Test, and Launch Operations by the end of 2010.
- Juno will deliver instruments and hardware in preparation for Assembly, Test, and Launch Operations in FY 2010.
- MSL will complete remaining hardware development, and will start to conduct the Rover System Environmental Test Program.
- MAVEN will complete its Preliminary Design Review in FY 2010.
- In February 2009, NASA will down-selected the Outer Planets Flagship from three science targets to focus on the Europa Jupiter System. In addition to further definition study and technology development efforts for the Europa Jupiter System Mission throughout FY 2010, NASA will also continue to negotiate the details of a potential partnership with the European Space Agency and other International Partners.
- Advanced Multi-Mission Operations System (AMMOS) will continue to develop multi-mission software tools for spacecraft navigation and mission planning.



Credit: NASA/JPL/Space Science Institute

Ring material, pulled to spectacular heights above the ring plane by the gravity of the moon Daphnis, casts long shadows on Saturn's A ring in this Cassini image taken about a month before the planet's August 2009 equinox. The shadows are as long as 310 miles, meaning the structures casting the shadows reach heights of almost 2.5 miles above the ring plane. These heights are much greater than those previously observed for the Daphnis edge waves and are very likely caused by the distance between Daphnis and the inner edge of its gap getting unusually small at certain times.

Outcome 3C.1: Progress in learning how the Sun's family of planets and minor bodies originated and evolved.

NASA scientists made interesting discoveries from analyzing particles from the comet Wild 2, collected by the Stardust mission. The sample from Wild 2 contained crystalline silicates, a rock forming mineral typically found in asteroids. Most asteroids in the solar system are concentrated in a belt between Mars and Jupiter. Wild 2 originated in the Kuiper Belt beyond

FY06	FY07	FY08	FY 2009
Green	Green	Green	Green

Neptune, and as a result, the mineral must have been transported from the asteroid belt to the cold, icy reaches of the Solar System to be incorporated into a comet. These findings show that the dust-gas cloud surrounding the primitive Sun before comets, asteroids, and planets began forming was a dynamic system. More information on the Stardust Mission mission can be found at the Jet Propulsion Laboratory Web site at www.jpl.nasa.gov/news/features.cfm?feature=1587.

The Cassini spacecraft has continued to explore Saturn's moon Titan and its organic chemistry, methane cycle, climate, geology, circulation, ionosphere, and magnetosphere. Like Earth, Titan has a significant atmosphere, which is of interest to researchers trying to understand the formation and evolution of minor bodies in the solar system. Researchers found that Titan has a methane hydrological cycle in which methane circulates on the moon through evaporation and precipitation. While methane dominates the atmosphere of Titan, researchers also discovered evidence of elements other than methane. Cassini also measured the shape of Titan and the north polar surface temperature, which may provide an explanation for the propensity of the lakes at the moon's pole.

Together, MESSENGER and Mariner observations of Mercury now provide a near-global look at the planet, revealing lateral and vertical mixes in the color, and thus composition, of Mercury's crust. Mapping the distribution and extent of major terrain types on Mercury will reveal clues to the origin and evolution of its crust. Smooth plains cover approximately 40 percent of the surface, and evidence suggests that a substantial portion of the crust originated volcanically.

The Mars Exploration Rover *Opportunity* explored and imaged the Victoria Crater, and one of the crater's alcoves, Duck Bay. The rover examined a section of layered rock more than ten meters thick in cliffs along the margin of Victoria crater and an eroded impact structure formed in sulfate-rich sedimentary rocks located about 3.75 miles south of the rover's landing site. The data from these examinations improved understanding of the major geological processes that formed the sedimentary rocks that underlie Mars' Meridiani plain. To learn more about *Opportunity*'s trip to Victoria crater, see marsrover.nasa.gov/newsroom/pressreleases/200905211.html.

FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
Demonstrate progress in learning how the Sun's family of planets and minor bodies originated and evolved. Progress will be evaluated by external expert review.	6SSE7 Green	7SSE1 Green	8PS01 Green	9PS1 Green
Develop missions in support of this Outcome, as demonstrated by completing the Juno Critical Design Review (CDR).	None	7SSE3 White	8PS03 Green	9PS2 Green
Develop missions in support of this Outcome, as demonstrated by completing the GRAIL mission Preliminary Design Review (PDR).	None	None	None	9PS3 Green
Develop missions in support of this Outcome, as demonstrated by completing the Mars Science Laboratory (MSL) Launch Readiness Review (LRR).	6SSE25 Green	7SSE5 Green	8PS05 Green	9PS4 Red

Why NASA did not achieve APG 9PS4: MSL did not complete the Launch Readiness Review. Development problems with electronic and mechanical devices resulted in slipping MSL's launch to the next Mars launch window in October through December 2011.

Plans for achieving 9PS4: NASA re-baselined MSL for launch in the October through December 2011 time-frame. The Launch Readiness Review has been rescheduled to support the new launch period in the first quarter of FY 2012.

Outcome 3C.2: Progress in understanding the processes that determine the history and future of habitability in the solar system, including the origin and evolution of Earth's biosphere and the character and extent of prebiotic chemistry on Mars and other worlds.

In FY 2009, NASA supported researchers gained new insight about the surface temperature of planets. The absorption of radiation in the atmosphere is regulated by the mechanisms associated with atmospheric pressure. Higher-pressure atmospheres absorb more radiation and hence keep the planet warm. This mechanism could be responsible for surface temperature regulation on Earth and presumably on other planets that may have allowed life to develop and to persist. The link between atmospheric pressure and temperature may help to explain the evolution of Earth's temperature as well as that of other planets including extra-solar planets.

FY06	FY07	FY08	FY 2009
Green	Green	Green	Green

Marking another achievement in pursuit of Outcome 3C.2, Cassini flew by Saturn's moon Enceladus several times in FY 2009, getting within 31 miles of this mysterious moon, and taking images in the visible and infrared, sampling the plume's composition, and making fields-and-particles measurements. The observations revealed evidence of sodium, and have stimulated discussion of the potential habitability of Enceladus because sodium salts could imply the presence of an ocean under the planet's icy surface. The magnetic field measurements currently being analyzed will be used to determine if Enceladus has an undercrust ocean. To read more about the efforts to understand this distant moon, visit www.jpl.nasa.gov/news/news.cfm?release=2009-101.

Another exciting discovery was made by the CRISM instrument on the MRO, offering a better understanding of habitability on Mars. Data from the instrument showed the presence of magnesite, a magnesium-rich carbonate, on the surface of Mars. Scientists have long expected to find carbonate on Mars because of its carbon dioxide rich atmosphere and the evidence of water. However, carbonate in bedrock outcrops clearly identifies the geologic environment where it formed and whether the environment could support life. More information can be found at the CRISM Web site at crism.jhuapl.edu/newscenter/articles/021607.php.

FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
Develop missions in support of this Outcome, as demonstrated by completing the Juno Critical Design Review (CDR).	None	7SSE3 White	8PS03 Green	9PS2 Green
Develop missions in support of this Outcome, as demonstrated by completing the Mars Science Laboratory (MSL) Launch Readiness Review (LRR).	6SSE25 Green	7SSE5 Green	8PS05 Green	9PS4 Red
Demonstrate progress in understanding the processes that determine the history and future of habitability in the solar system, including the origin and evolution of Earth's biosphere and the character and extent of prebiotic chemistry on Mars and other worlds. Progress will be evaluated by external expert review.	6SSE12 Green	7SSE4 Green	8PS04 Green	9PS5 Green
	6SSE13 Green			
	6SSE14 Green			
	6SSE15 Green			
	6SSE16 Green			
	6SSE17 Green			
	6SSE18 Green			
6SSE19 Yellow				
Develop missions in support of this Outcome, as demonstrated by selecting the next Scout mission.	None	None	None	9PS6 Green
Conduct flight program in support of this Outcome, as demonstrated by achieving mission success criteria for Phoenix.	None	7SSE7 Green	8PS07 Green	9PS7 Green

Why NASA did not achieve APG 9PS4: MSL did not complete the Launch Readiness Review. Development problems with electronic and mechanical devices resulted in slipping MSL's launch to the next Mars launch window in October through December 2011.

Plans for achieving 9PS4: NASA re-baselined MSL for launch in the October through December 2011 time-frame. The Launch Readiness Review has been rescheduled to support the new launch period in the first quarter of FY 2012.

Outcome 3C.3: Progress in identifying and investigating past or present habitable environments on Mars and other worlds, and determining if there is or ever has been life elsewhere in the solar system.

The EPOXI mission has imaged Earth in several different colors, producing images that increase confidence that spotting Earth-like planets from afar is within reach. The team processed these images to produce

FY06	FY07	FY08	FY 2009
Green	Green	Green	Green

so-called “alien maps of planet Earth” which show what Earth, or other potentially life-supporting planets, might look like from interstellar distances. The alien maps show Earth’s continents and oceans, and prove that topography on an Earth-like extra-solar planet can be reconstructed from images that contain only a pale blue dot.

Planetary Astronomy Program scientists continued to unveil secrets of the Mars environment with the detection of methane in groundwater and in Mars’ atmosphere. The presence of methane, typically a waste gas from living organisms, proves that Mars is surprising active geologically or biologically. For more information, see www.nasa.gov/home/hqnews/2009/jan/HQ_09-006_Mars_Methane.html.

In addition to the clues methane provides about the habitability of Mars, scientists have also made discoveries through studying ice glaciers, and the planet’s soil chemistry that affect groundwater, a key to habitability. Ice content on Mars, both past and present, has been highly debated. SHARAD, the radar on MRO, indicates the presence of large quantities of ice just below a thin layer of rock/dust. These deposits are widespread, large, and given their latitudes, are relatively accessible to future landed missions for studies of past climate, the search for sub-ice habitats, and for resources to support exploration. For more information visit the MRO Web site at www.nasa.gov/mission_pages/MRO/news/mro-20081120.html.

An unexpected result from the Mars Phoenix mission is the discovery of the powerful oxidant, perchlorate. Measurements found sufficient concentrations of perchlorate to have important affects on soil chemistry. For instance, perchlorate is highly hygroscopic (water absorbing), meaning it can affect the freezing point of water, allowing liquid water at sub-zero temperatures. In addition, its hygroscopic nature and concentration may be controlling the relative humidity of the polar area.

FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
Develop missions in support of this Outcome, as demonstrated by completing the Juno Critical Design Review (CDR).	None	7SSE3 White	8PS03 Green	9PS2 Green
Develop missions in support of this Outcome, as demonstrated by completing the Mars Science Laboratory (MSL) Launch Readiness Review (LRR).	6SSE25 Green	7SSE5 Green	8PS05 Green	9PS4 Red
Develop missions in support of this Outcome, as demonstrated by selecting the next Scout mission.	None	None	None	9PS6 Green
Conduct flight program in support of this Outcome, as demonstrated by achieving mission success criteria for Phoenix.	None	7SSE7 Green	8PS07 Green	9PS7 Green
Demonstrate progress in identifying and investigating past or present habitable environments on Mars and other worlds, and determining if there is or ever has been life elsewhere in the solar system. Progress will be evaluated by external expert review.	6SSE20 Yellow	7SSE6 Green	8PS06 Green	9PS8 Green

Why NASA did not achieve APG 9PS4: MSL did not complete the Launch Readiness Review. Development problems with electronic and mechanical devices resulted in slipping MSL’s launch to the next Mars launch window in October through December 2011.

Plans for achieving 9PS4: NASA re-baselined MSL for launch in the October through December 2011 timeframe. The Launch Readiness Review has been rescheduled to support the new launch period in the first quarter of FY 2012.

Outcome 3C.4: Progress in exploring the space environment to discover potential hazards to humans and to search for resources that would enable human presence.

A unique event occurred for the first time in the last year, allowing scientists to collect remnants of a meteorite fall from a parent asteroid whose origin is known. On October 6, 2008, a Near Earth Object Observation Program search project, the Catalina Sky Survey, spotted a small asteroid just one day before it would impact the Earth. Designated object 2008 TC3, the NEO observer network was quickly alerted by the Minor Planet Center and over 570 observations were collected by 27 different observers worldwide, including spectrometric data, within the 19 hours before it impacted the Earth’s atmosphere. The impact occurred in the early morning of October 7 at the time and location precisely predicted by the NEO Program’s SENTRY impact prediction system, over northern Sudan in eastern Africa. Within a few weeks, NASA scientists and a student team

FY06	FY07	FY08	FY 2009
Green	Green	Green	Green

organized by the University of Khartoum were collecting fresh meteorites along the ground track predicted by NASA's analysis.

This was the first time that a very small asteroid on collision course with Earth was spotted before it impacted, making it possible for science teams to be alerted to first collect measurements via remote sensors of the object while it was still in space, and then prepare to search for remnants of the object on the ground. As a result, fresh and practically uncontaminated fragments have been collected of an object very recently observed in space and the celestial origin of the collected samples is known. This is the next best thing to an asteroid sample return mission. More information is available from *Nature* at www.nature.com/news/2009/090325/pdf/458401a.pdf.

In FY 2009, asteroid search teams funded by NASA's Near Earth Object Observation Program found 21 asteroids larger than one kilometer (0.62 miles) in size with orbits coming within Earth's vicinity. In addition, the teams also found 805 smaller asteroids of less than one kilometer in mean diameter, bringing the total number of known asteroids of all sizes to 6,398. Two more Earth-approaching comets were also found this year. The high-precision orbit predictions computed by NASA's Jet Propulsion Laboratory show that none of these objects are likely to hit Earth in the next century. However, 1,066 are in orbits that could become a hazard in the more distant future and warrant monitoring, of which 145 are larger than one kilometer in diameter. Of all these potential hazards, 92 were found this year alone, four larger than one kilometer in diameter. Taking all the new discoveries into account, 792 near-Earth asteroids larger than one kilometer have been found to date and the teams' progress toward the goal of finding 90 percent of these objects is as high as 84 percent of the total existing objects of that size.

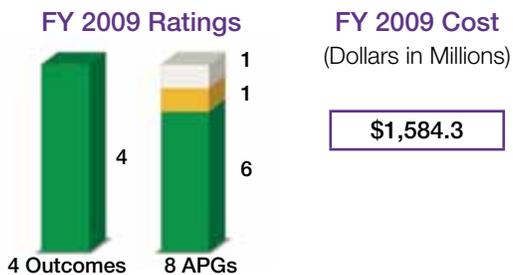
FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
Develop missions in support of this Outcome, as demonstrated by completing the Mars Science Laboratory (MSL) Launch Readiness Review (LRR).	6SSE25 Green	7SSE5 Green	8PS05 Green	9PS4 Red
Conduct flight program in support of this Outcome, as demonstrated by achieving mission success criteria for Phoenix.	None	7SSE7 Green	8PS07 Green	9PS7 Green
Demonstrate progress in exploring the space environment to discover potential hazards to humans and to search for resources that would enable human presence. Progress will be evaluated by external expert review.	6SSE5 Green	7SSE8 Green	9PS08 Green	9PS9 Green
Develop missions in support of this Outcome, as demonstrated by selecting instruments for the first Lunar Science Research mission.	None	None	None	9PS10 Green

Why NASA did not achieve APG 9PS4: MSL did not complete the Launch Readiness Review. Development problems with electronic and mechanical devices resulted in slipping MSL's launch to the next Mars launch window in October through December 2011.

Plans for achieving 9PS4: NASA re-baselined MSL for launch in the October through December 2011 timeframe. The Launch Readiness Review has been rescheduled to support the new launch period in the first quarter of FY 2012.

Sub-Goal 3D

Discover the origin, structure, evolution, and destiny of the universe, and search for Earth-like planets.



Using space-based telescopes, which provide access to wavelengths obscured by Earth's atmosphere, NASA enables research to understand the structure, content, and evolution of the universe. This research provides information about humankind's origins and the fundamental physics that govern the behavior of matter, energy, space, and time, and aids the search for life elsewhere in the Universe. NASA-supported researchers look far into the universe, towards the beginning of time, to see galaxies forming. They also search for Earthlike planets around distant stars, determine if life could exist elsewhere in the galaxy, and investigate the processes that formed Earth's solar system.¹⁰

Benefits

NASA's astrophysics missions—particularly the three Great Observatories: the Hubble Space Telescope, the Spitzer Space Telescope, and the Chandra X-ray Observatory—have provided researchers with new ways of looking at the universe so that they can expand knowledge about cosmic origins and fundamental physics. The interesting and beautiful images from these observatories also are educational tools to help spark student interest in science, technology, engineering, and mathematics and serve to prominently illustrate the role of the United States in scientific exploration.

Stunning images produced from Astrophysics' operating missions continue to inspire the public, revealing the beauty of our universe and the science behind those images. NASA provides the tools to translate the science for the classroom and other learning venues in ways that meet educator needs. The Space Telescope Science Institute's "Amazing Space" Web site (amazing-space.stsci.edu/) provides curriculum support tools based on Hubble Space Telescope images and research to classrooms nationwide.

Spitzer Space Telescope "Cool Cosmos" Web site (coolcosmos.ipac.caltech.edu/) offers explorations into the world of the infrared, and the Chandra X-ray Observatory Web site (chandra.harvard.edu/) offers information for children, students, educators, planetariums, and the general public.

The study of the universe benefits the Nation's scientific research community by focusing research and advanced technology developments on optics, sensors, guidance systems, and propulsion systems. Some of these new and improved technologies enable ground-breaking capabilities, which are then available to both the commercial and defense sectors.

Risks to Achieving Sub-goal 3D

The primary concern for the Astrophysics Division is keeping the development of the James Webb Space Telescope (JWST) on schedule and within budget. Because its annual budget is a substantial fraction of the Division budget, schedule delays and cost overruns on JWST could significantly impact the Division's ability to respond to the National Research Council's Astro2010 Decadal Survey. Schedule delays occurring on SOFIA to the start of science observations are also a concern. These observations are important to the science community (both in the U.S. and Germany) to start demonstrating the scientific capability of SOFIA.

Finally, the availability of Expendable Launch Vehicle (ELV) options for small and medium-class missions is also a concern. The lack of reliable and affordable launch vehicle options may impair the Division's ability to sustain a scientifically and programmatically balanced portfolio during the next decade.

¹⁰For more information on NASA missions, please see NASA's Missions at a Glance, located in the *Other Accompanying Information* section of this document.

FY 2010 Performance Forecast

- Senior Reviews for operating missions and archives were conducted in the spring 2008; those results are reflected in the 2010 budget. A comparative evaluation of all Astrophysics operating missions is conducted every two years (next review scheduled for spring of 2010), and of the archives every four years. The science output is evaluated by an independent expert panel, and decisions are made as to which missions will receive funding for extended operation.
- In Research and Analysis, peer-reviewed investigations are supported in the areas of past missions data analysis, and theoretical studies or modeling of the astrophysical phenomena targeted by past, current, and future missions. Laboratory studies of astrophysical phenomena, limited ground-based observing, and suborbital missions will also continue in FY 2010.
- The Balloons project will continue to work toward advancing the capability of the new super-pressure balloon, which will be used to carry large scientific experiments to the brink of space for 100 days or more.
- The next major milestone for JWST is the Critical Design Review, which is a review of the complete system design, and is scheduled to take place in FY 2010.
- SOFIA early science flights will be the first demonstration of the SOFIA system as an operating astronomical observatory; the science will be conducted using two instruments aboard SOFIA: FORCAST (U.S. instrument) and GREAT (German instrument). The first early science observations by the SOFIA science team are scheduled to begin in FY 2010, while the first competed science observations by the broader astronomical community are planned in 2011.
- Kepler, Fermi, Herschel, and Planck will remain in prime operations phase and Chandra will continue in extended operations.
- The Spitzer Space Telescope's cryogen supply has run out. This means the spacecraft is operating at warmer temperatures. The remaining imaging capabilities still exceed what is available from the ground, and will be unmatched until the launch of JWST. Warm Spitzer is a powerful and unique facility for projects that require precise photometry, and for deep large-scale surveys at near/mid-infrared wavelengths. The spacecraft is funded for two years of warm operations, per results of the 2008 operating missions Senior Review. Spitzer will be reviewed again in the 2010 Senior Review to determine whether to extend warm operations.
- WISE is scheduled for launch in December 2009. The projected lifetime of the mission is 10 months.
- The High-Resolution Soft X-Ray Spectrometer (SXS) instrument was selected in 2008 as a Mission of Opportunity and is scheduled to fly on the Japanese Astro-H mission in 2013. This instrument is planned to transition from the definition to the design phase in FY 2010.
- The NuSTAR mission will hold its confirmation review in preparation to enter development phase in FY 2010.
- The GEMS SMEX mission, selected in 2009 for a 2014 launch, is undergoing formulation. The next major milestone for GEMS is Systems Requirement Review, which is scheduled to take place in July 2010.



Credit: ESA/Hubble, NASA and the SM4 ERO team

As one of the first pictures taken with the new Wide Field Camera 3 (WFC3), NASA's Hubble Space Telescope snapped this image of the planetary nebula NGC 6302, more popularly called the Bug Nebula or the Butterfly Nebula. Astronauts installed WFC3 in May 2009 during the servicing mission to upgrade and repair the 19-year-old Hubble telescope.

Outcome 3D.1: Progress in understanding the origin and destiny of the universe, phenomena near black holes, and the nature of gravity.

NASA’s WMAP satellite observes the most ancient light in the universe—cosmic microwave background radiation, the radiant heat left over from the Big Bang. Through these observations, WMAP gives researchers access to a wellspring of information about physical conditions in the early universe. Recent publications based on WMAP data accurately describe the features of the early universe and reveal hints about how it began. The WMAP team determined the universe’s age to be 13.7 billion years, with accuracy better than one percent (or 0.12 billion years, a small amount when working on such a vast scale), its shape (uncurved) with a precision of 0.5 percent, and its rate of expansion with accuracy better than four percent. The WMAP results also show that only 4.6 percent of the universe exists in atoms, with the remainder in dark matter and dark energy. This supports the theory that the vast majority of the mass in the observable universe is made up of dark matter and dark energy. Furthermore, researchers believe that dark matter and dark energy play a central role in structure formation and galaxy evolution, and has measurable effects on the anisotropy of the cosmic microwave background. However, researchers do not have direct evidence of their existence or a concrete understanding of their nature. For more on this mission go to map.gsfc.nasa.gov/.

FY06	FY07	FY08	FY 2009
Green	Green	Green	Green

NASA’s Chandra X-ray Observatory has been helping researchers better understand the nature of dark energy and through it, a better understanding of the origin and destiny of the universe. Dark energy is responsible for the acceleration of the universe’s expansion. In December 2008, researchers released illustrations from their examination of galaxy cluster Abell 85, one of 86 clusters observed by Chandra to trace how dark energy has stifled the growth of these massive structures over the last seven billion years. By using Chandra to observe the hot gas in the galaxy clusters, they determined the change in the masses of clusters over time. The growth of the galaxy structures was initially driven only by the attractive force of gravity, but then the repulsive force of dark energy helped drive expansion. For more information and images go to chandra.harvard.edu/press/08_releases/press_121608.html.

NASA’s Swift satellite and an international team of astronomers announced that they had found a gamma-ray burst, called GRB 090423, from when the universe was only 630 million years old and 9.3 times smaller than its current size. The photons observed by the Swift satellite spent 13 billion years reaching Earth. Gamma-ray bursts emit enormous amounts of energy: about 10⁵³ ergs. In comparison, the Sun only puts out about 10³³ ergs, so it would take the Sun 880 billion years to put out the same energy as a gamma-ray burst. Swift is helping researchers confirm theories that gamma-ray bursts are caused either by neutron star/neutron star mergers or hypernovae. With both theories, a black hole is formed, releasing a large amount of energy that is seen as the flash of a gamma-ray burst. The Swift observation is the most distant cosmic explosion ever seen, likely from the death of a star and the birth of a black hole in, what one of the researchers called, “one of the universe’s earliest stellar generations.” Directly observing the death of a star very early in the universe helps researcher understand how stars formed and also pinpoints the presumed location of the most distant galaxy found to date. For more on this story go to www.nasa.gov/mission_pages/swift/bursts/cosmic_record.html.

FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
Demonstrate progress in understanding the origin and destiny of the universe, phenomena near black holes, and the nature of gravity. Progress will be evaluated by external expert review.	6UNIV8 Green	7UNIV1 Green	8AS01 Green	9AS1 Green
	6UNIV9 Green			
	6UNIV10 Green			
	6UNIV11 Green			
	6UNIV12 Green			
	6UNIV13 Green			
	6UNIV15 Green			

FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
Develop missions in support of this Outcome, as demonstrated by releasing the Joint Dark Energy Mission (JDEM) Announcement of Opportunity (AO).	None	None	None	9AS2 White

Why NASA rated APG 9AS2 White: In early calendar year 2009, NASA and the Department of Energy agreed that the JDEM Announcement of Opportunity (the peer-reviewed method NASA uses to solicit research proposals from the community) would be held pending further interagency discussions regarding the definition and development of the mission. The 2010 Astrophysics Decadal Survey, conducted by the National Research Council (NRC), is currently reviewing all Federal astrophysics research plans and will provide a report with findings to NASA. Administration plans for the JDEM mission will not proceed further until the NRC report is released in mid-calendar year 2010.

Outcome 3D.2: Progress in understanding how the first stars and galaxies formed, and how they changed over time into the objects recognized in the present universe.

An analysis of archival images of small, or dwarf, galaxies taken by NASA's Hubble Space Telescope suggests that starbursts, intense regions of star formation, sweep across the whole galaxy and last 100 times longer than astronomers previously thought. The longer duration may affect how dwarf galaxies change over time and, therefore, may shed light on galaxy evolution. Researchers consider dwarf galaxies to be the building blocks of the large galaxies seen today, so the length of starbursts is important for understanding how galaxies evolve. Analysis showed that starburst activity in a dwarf galaxy happens on a global scale, with pockets of intense star formation propagating throughout the galaxy, like a string of firecrackers going off. The duration of all the starburst events in a single dwarf galaxy would total 200 million to 400 million years. Information and images are available at www.nasa.gov/mission_pages/hubble/science/hstimg_starbursts.html.

FY06	FY07	FY08	FY 2009
Yellow	Green	Green	Green

The first results released by BLAST, a balloon-borne mission, provide more data on previous starbursts in the universe. BLAST research determined that the far-infrared background, originally discovered by the COBE mission in 1996, arises from the cumulative emission from large numbers of individual galaxies that are forming stars at a prodigious rate—hundreds of times the rate of star formation in the Milky Way galaxy. Star formation takes place in clouds composed of hydrogen gas and a small amount of dust. The dust absorbs the starlight from young, hot stars, heating the clouds to roughly 30 degrees above absolute zero (or 30 Kelvin). The light is re-emitted at much longer infrared and submillimeter wavelengths. As much as 50 percent of the universe's light energy is infrared light from young, forming galaxies. In fact, there is as much energy in the far-infrared background as there is in the total optical light emitted by stars and galaxies in the universe.

Researchers using a number of Earth-based optical and radio telescopes and the Spitzer Space Telescope have discovered a new record-holder for the brightest starburst galaxy in the very distant universe. Dubbed the Baby Boom galaxy, it is forming new stars at a rate of 1,000 to 4,000 per year, compared to the Milky Way's very modest ten stars per year. This discovery is significant because the galaxy is 12.3 billion light years away, making it a young galaxy. However, a young galaxy undergoing a major baby boom goes against the most commonly held theory of galaxy formation, where large galaxies build up stars slowly and absorb small pieces of galaxies instead of forming most of its stars all at once. Understanding the Baby Boom galaxy will help researchers refine understanding of how galaxies are formed and how they have changed over the history of the universe.

In a landmark study of more than 2,000 spiral galaxies imaged by Hubble, astronomers found that barred spiral galaxies, galaxies with large cigar-shaped bars of stars in their central regions like the Milky Way, are one third as plentiful seven billion years ago as they are today. Bars are important in galaxy evolution because they force a large amount of gas towards the galactic center, fueling new star formation, building central bulges of stars, and feeding massive black holes. The study's results confirm the idea that bars are a sign of galaxies reaching full maturity when their formative years end. More information and images are available at hubblesite.org/newscenter/archive/releases/galaxy/spiral/2008/29/full/.

GALEX mission has, for the first time, identified dwarf galaxies forming out of pristine gas likely leftover from the early universe. The findings surprised researchers because most galaxies form in association with dark matter or out of gas containing metals, produced as stars evolve. GALEX spotted the unexpected new galaxies forming inside the Leo Ring, a huge cloud of hydrogen and helium that researchers believe is a primordial object, an ancient remnant

of material that has remained relatively unchanged since the very earliest days of the universe. This new type of dwarf galaxy may be common throughout the early universe, when pristine gas—enriched with gas and dark matter recycled from other galaxies—was more pervasive.

FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
Demonstrate progress in understanding how the first stars and galaxies formed, and how they changed over time into the objects we recognize in the present universe. Progress will be evaluated by external expert review.	6UNIV14 Green	7UNIV5 Green	8AS03 Green	9AS3 Green
	6UNIV16 Yellow			
	6UNIV17 Green			
Develop missions in support of this Outcome, as demonstrated by completing the James Webb Space Telescope (JWST) Integrated Science Instrument Module (ISIM) Critical Design Review (CDR).	6UNIV20 Red	7UNIV4 Green	8AS04 Green	9AS4 Green
Develop missions in support of this Outcome, as demonstrated by beginning Stratospheric Observatory for Infrared Astronomy (SOFIA) open-door testing.	6UNIV18 Red	None	None	9AS5 Yellow

Why NASA did not achieve APG 9AS5: The vendor was late delivering the telescope cavity door controller, causing the delay in testing. The telescope cavity door controller opens and closes a 25-foot-long door on a highly modified 747 aircraft and is, therefore, a flight safety critical system. NASA uncovered technical and quality issues with the controller work at the vendor’s facility, requiring NASA project management to station representatives at the facility to oversee the final work leading to the late delivery. This led to a delay in the integration and testing of the controller on the aircraft, and consequently the delay in the open-door flight testing.

Plans for achieving APG 9AS5: The open-door flight testing is scheduled to begin in FY 2010.

3D.3: Progress in understanding how individual stars form and how those processes ultimately affect the formation of planetary systems.

FY06	FY07	FY08	FY 2009
Yellow	Green	Green	Green

The Spitzer Space Telescope was prolific in star formation science this year, providing new insights into how stars form and how their natal disks of dust and gas go on to form their planetary systems. Using Spitzer infrared images researchers have uncovered newborn stars at the center of the Milky Way galaxy. Before now, there were only a few clues that stars can form in the galaxy’s core. The heart of the Milky Way is cluttered with stars, dust, and gas, and at its very center is a supermassive black hole. Conditions there are harsh, with fierce stellar winds, powerful shock waves, and other factors that make it difficult for stars to form. The dust made it difficult to locate baby stars. The Spitzer infrared instruments made it possible to identify more than 100 candidates for young stars, all less than one million years old. The data helps researchers understand how stars can form in such inhospitable environments. The press release and images are available at www.spitzer.caltech.edu/Media/releases/ssc2009-13/release.shtml.

Another new image from Spitzer provides evidence that massive stars, through their brute winds and radiation, can trigger the birth of stellar newborns. Researchers used Spitzer to peer through the dusty clouds in W5 and get a better look at stars in various stages of evolution. They found that stars within the W5 cavities are older than stars at the rims, and even older than stars farther out past the rim. This ladder-like separation of ages provides some of the best evidence yet that massive stars give rise to younger generations. The press release and images are available at www.spitzer.caltech.edu/Media/releases/ssc2008-15/release.shtml and a video entitled “The W5 Stellar Blast Furnace” is available on the Spitzer Hidden Universe page at spitzer.caltech.edu/video-audio/381-hiddenuniverse026-Gallery-Explorer-Orion-Nebula.

Researchers used Spitzer to look for the life-forming chemical hydrogen cyanide in the planet-forming material swirling around different types of stars. Hydrogen cyanide is a component of adenine, a basic element of DNA. The researchers detected hydrogen cyanide molecules in disks circling yellow stars like the Sun, but found none around cooler and smaller stars like M-dwarfs and brown dwarfs common throughout the universe. The findings have implications for planets that have recently been discovered around M-dwarf stars. Researchers think some of these

planets are large versions of Earth, but they do not believe the planets orbit in a habitable zone, where water would be liquid. Furthermore, M-dwarfs have extreme magnetic outbursts that could be disruptive to developing life. The press release and images are available at www.spitzer.caltech.edu/Media/releases/ssc2009-09/release.shtml.

FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
Develop missions in support of this Outcome, as demonstrated by completing the James Webb Space Telescope (JWST) Integrated Science Instrument Module (ISIM) Critical Design Review (CDR).	6UNIV20 Red	7UNIV4 Green	8AS04 Green	9AS4 Green
Develop missions in support of this Outcome, as demonstrated by beginning Stratospheric Observatory for Infrared Astronomy (SOFIA) open-door testing.	6UNIV18 Red	None	None	9AS5 Yellow
Demonstrate progress in understanding how individual stars form and how those processes ultimately affect the formation of planetary systems. Progress will be evaluated by external expert review.	6UNIV1 Green	7UNIV6 Green	8AS06 Green	9AS6 Green
	6UNIV2 Green			

Why NASA did not achieve APG 9AS5: The vendor was late delivering the telescope cavity door controller, causing the delay in testing. The telescope cavity door controller opens and closes a 25-foot-long door on a highly modified 747 aircraft and is, therefore, a flight safety critical system. NASA uncovered technical and quality issues with the controller work at the vendor's facility, requiring NASA project management to station representatives at the facility to oversee the final work leading to the late delivery. This led to a delay in the integration and testing of the controller on the aircraft, and consequently the delay in the open-door flight testing.

Plans for achieving APG 9AS5: The open-door flight testing is scheduled to begin in FY 2010.

Outcome 3D.4: Progress in creating a census of extra-solar planets and measuring their properties.

This year, two new techniques have been added to astronomers' toolkits for discovering planets: direct imagery and astrometry, measurements of how a star wobbles on the plane of the sky.

FY06	FY07	FY08	FY 2009
Yellow	Yellow	Green	Green

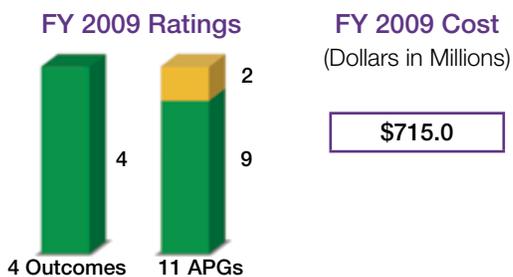
As each year goes by, researchers learn more about the properties of exoplanets, the planets beyond Earth's solar system. In December 2008, researchers announced that the Hubble Space Telescope discovered carbon dioxide on the Jupiter-sized planet HD 189733b. Researchers discovered the planet earlier in the decade and already knew that its atmosphere contains water vapor and methane. The Hubble observation is an important step to finding the chemical biotracers of life as we know it. HD 189733b is too hot for life, but the Hubble observations are a proof-of-concept demonstration that NASA's current suite of space-based instruments can measure the basic chemistry for life on planets orbiting other stars. Researchers used Hubble's Near Infrared Camera and Multi-Object Spectrometer to study infrared light emitted from HD 189733b. Gases in the planet's atmosphere absorb certain wavelengths of light from the planet's hot glowing interior. Astronomers identified not only carbon dioxide, but also carbon monoxide. This is the first time a near-infrared emission spectrum has been obtained for an exoplanet. The press release and images are available at hubblesite.org/newscenter/archive/releases/2008/41/full/.

The Spitzer Space Telescope observed a planet, HD 80606b, that heats up to red-hot temperatures in hours before quickly cooling back down. A gas giant orbiting a star 190 light-years from Earth, HD 80606b was already known to be quite unusual, with an orbit that on one end is almost as far from the star as Earth is from the Sun, and on the other end is much closer in than Mercury to the Sun. Astronomers used Spitzer to measure heat emanating from the planet as it whipped behind and close to its star. In just six hours, the planet's temperature rose from 980 to 2,240 degrees Fahrenheit. The extreme temperature swing indicates that the air near the planet's gaseous surface must quickly absorb and lose heat. This is the first time that researchers have obtained atmospheric information revealing how a planet responds to sudden changes in heating—an extreme version of seasonal change. The press release and images are available at www.spitzer.caltech.edu/Media/releases/ssc2009-02/release.shtml.

FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
Demonstrate progress in creating a census of extra-solar planets and measuring their properties. Progress will be evaluated by external expert review.	6UNIV3 Green	7UNIV7 Green	8AS07 Green	9AS7 Green
	6UNIV4 Green			
	6UNIV5 Yellow			
Develop missions in support of this Outcome, as demonstrated by completing Kepler Launch Readiness Review (LRR).	6UNIV21 Yellow	7UNIV8 Green	8AS08 Green	9AS8 Green

Sub-Goal 3E

Advance knowledge in the fundamental disciplines of aeronautics, and develop technologies for safer aircraft and higher capacity airspace systems.



NASA is the Nation's leading government organization for aeronautical research. This world-class capability is built on a tradition of expertise in core disciplines like aerodynamics, acoustics, combustion, materials and structures, and dynamics and control. In FY 2009, NASA's aeronautics research was comprised of four programs:

- The Fundamental Aeronautics Program has the principal objective of overcoming today's national challenges in air transportation, including public concern over noise and emissions, increasing costs associated with high fuel consumption, and progress towards faster means of transportation. The program develops focused technological capabilities and conducts research to enable the design of vehicles that fly through any atmosphere at any speed. Future aircraft must address multiple design challenges, and therefore a key focus will be the development of physics-based, multidisciplinary design, analysis, and optimization (MDAO) tools.

- The Aviation Safety Program develops innovative tools, concepts, methods, and technologies that will improve the intrinsic safety attributes of current and future aircraft and that will help overcome aviation safety challenges that would otherwise constrain the full realization of the Next Generation Air Transportation System (NextGen).

- The Airspace Systems Program conducts research to enable NextGen capabilities such as foundational research in multi-aircraft flow and airspace optimization, trajectory design and conformance, separation methods, and adaptive systems. The Airspace Systems Program research for the airspace and airportal domains is integrated into gate-to-gate solutions.

- The Aeronautics Test Program (ATP) ensures the strategic availability and accessibility of a critical suite of major wind tunnels at Ames, Glenn, and Langley Research Centers, and flight operations assets at the Western Aeronautical Test Range, support/testbed aircraft, and simulation and loads labs at Dryden Flight Research Center.

Benefits

NASA's aeronautics program ensures long-term focus in fundamental research in both traditional aeronautical disciplines and relevant emerging fields for integration into multidisciplinary system-level capabilities for broad application. This approach will enable revolutionary change to both the airspace system and the aircraft that fly within it, leading to a safer, more environmentally friendly, and more efficient national air transportation system. Furthermore, Aeronautics Research Mission Directorate (ARMD) will disseminate all of its research results to the widest practical and appropriate extent (consistent with foreign policy and national security).

ARMD uses the NASA Research Announcement (NRA) process to foster collaborative research partnerships with the academic and private sector communities. The NRA process encourages awardees to spend time at NASA Centers in order to enhance the exchange of ideas and expand the learning experience for everyone involved. Furthermore, ARMD has focused its educational activities to better attract the Nation's best and brightest students to aeronautics. These activities include design competitions and the establishment of graduate and undergraduate scholarships and internships.

Risks to Achieving Sub-goal 3E

NASA identifies highly challenging, cutting-edge aeronautics research goals that, by their nature, are inherently high risk. Even if each milestone is not met, the lessons that NASA learns advance the aeronautics state of knowledge and helps the Agency make informed decisions to realign research to the appropriate areas. Redirection of

resources to meet other national priorities is another major risk to NASA's programs and schedules. Should this occur, ARMD will re-align program milestones and schedules as needed to respond to the changes.

The Fundamental Aeronautics, Aviation Safety, Airspace Systems, and Aeronautics Test Programs partner with other government agencies, industry, and universities to meet program objectives. These partnerships provide many benefits, but also introduce external dependencies that could influence schedules and research output. The programs will mitigate this risk through close coordination with these partners.

FY 2010 Performance Forecast

In FY 2010, ARMD will continue its commitment to conducting long-term, cutting-edge research for the benefit of the broad aeronautics community. Each of the five programs within ARMD will play a significant role in FY 2010 in addressing the challenge of meeting the growing capacity needs of the NextGen as well as contributing to the research and development challenges in aviation safety, promising new flight regimes, and aviation environmental impacts. Specifically,

- The Aviation Safety Program will take a proactive approach to safety challenges with new and current vehicles and with operations in the Nation's current and future air transportation system; the Program is initiating an effort to examine key challenges in verifying and validating flight critical software systems;
- The Airspace Systems Program will develop and enable future concepts, capabilities, and technologies that will enable major increases in air traffic management effectiveness, flexibility, and efficiency, while maintaining safety, to meet capacity and mobility requirements of the NextGen;
- The Fundamental Aeronautics Program will continue to develop prediction and analysis tools for reduced uncertainty in design process and advanced multidisciplinary design and analysis capability to guide our research and technology investments and realize integrated technology advances in future aircraft;
- The Aeronautics Test Program will ensure the strategic availability, accessibility, and capability of a critical suite of aeronautics ground test facilities and flight operations assets necessary for Agency and National aeronautics needs; and
- The Integrated Systems Research Program's initial effort will take an integrated system-level approach to reduce the environmental impact of aviation (in terms of noise, local and global emissions, and local air quality) in the area of air vehicle technologies.



Credit: NASA

Tests in a NASA wind tunnel of this SMART rotor hub confirm the ability of advanced helicopter-blade active control strategies to reduce vibrations and noise.

Outcome 3E.1: By 2016, identify and develop tools, methods, and technologies for improving overall aircraft safety of new and legacy vehicles operating in the Next Generation Air Transportation System (projected for the year 2025).

Accurate, real-time performance parameters, along with in-flight measurements, can be directly utilized by aircraft engine controls and health management applications to improve aircraft safety. A challenge that complicates this practice is the fact that an aircraft engine's performance is affected by its level of degradation, which is described in terms of immeasurable health parameters such as the efficiency or flow capacity of each major engine component. Through mathematical techniques, the health parameters, and thus level of engine performance degradation, can be estimated. To do so, the mathematical techniques require that the number of sensors within the engine be greater than or equal to the number of parameters to be estimated. However, in an aircraft engine, the number of sensors available is typically less than required.

FY06	FY07	FY08	FY 2009
Green	Green	Green	Green

A common approach to address this shortcoming is to estimate a sub-set of the health parameters. The problem with this approach is that it can introduce significant error in the estimation of overall engine health and

performance. NASA's Integrated Vehicle Health Management project developed an innovative method that reduces estimation error in overall engine health and performance. NASA validated the new methodology in a simulation using an aircraft turbofan engine model. The results agreed with theoretical predictions and demonstrated that applying the enhanced technique resulted in a 31.6 percent reduction in average estimation error compared to a conventional approach.

The Aircraft Aging and Durability project developed a process to increase the capability for nickel-based superalloy disks (as would be used in the high pressure stage of a turbine engine) to run at higher temperatures, while maintaining the required high stress and cycle life. This process will allow for safe, durable operations under the conditions required for future engine designs.

The Integrated Intelligent Flight Deck project displays, with a mix of visual and auditory components for uncertainty, concepts and virtual visual environments. Simulations found significant reductions in communication errors, mental workload, and flight technical error in users, as well as increases in usability and situational awareness when measured using the multi-modal presentation formats and interaction methods in the NextGen terminal area operations as compared to the current flight deck systems in current air traffic terminal area operations.

The Integrated Resilient Aircraft Control project developed and evaluated concepts for on-line integrity monitoring through simulation tests of control systems which adapt to changing flight conditions. The results demonstrated that failure of the adaptive control can be detected at least 99 percent of the time. In developing the adaptive control systems, it is critical that safeguards be in-place to prevent the automation itself from causing of new unforeseen failures.

FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
Demonstrate a 10% improvement in estimation accuracy of integrated gas path sensing and diagnostics for aircraft engine health.	6AT4 Green	7AT1 Green	8AT04 Green	9AT1 Green
	6AT14 Yellow			
	6AT15 Yellow			
Conduct a spin test to verify enhanced disk rim attachment strength at component level and show 10% life improvement over criteria established in 2007.	None	7AT1 Green	None	9AT2 Yellow
Assess and deliver findings on initial multi-modal presentation formats and interaction methods for uncertainty display concepts and virtual visual environments with statistically significant reductions in communication errors, mental workload, and flight technical error, as well as increases in usability and situation awareness compared with baseline capability.	6AT14 Yellow	7AT1 Green	8AT02 Green	9AT3 Green
	6AT15 Yellow			
Design and evaluate preliminary concepts in on-line integrity monitoring (99% failure detection with less than 1% false positives) for adaptive control systems through simulation tests.	None	7AT1 Green	None	9AT4 Green

Why NASA did not achieve APG 9AT2: The final spin test to validate the performance did not occur prior to the end of FY 2009 because of test facility problems. NASA Glenn Research Center delivered two superalloy disks and an oven to the Space Act Agreement (SAA) partner, who agreed to conduct a Spin Pit Test on the superalloy to see if the disk could withstand 10,000 cycles at 1,300 degrees Fahrenheit. In April 2009, the SAA partner began calibrating the government-provided oven to ensure it maintained an acceptable 1,300 degrees Fahrenheit. During this checkout, the oven did not maintain a stable temperature. As a result, the SAA partner purchased a new oven that was delivered and checked out by July 31, 2009, resulting in a normal two-week shutdown of the test facilities. During calibration on August 10, 2009, the new oven met temperature requirements, but failed due to mechanical reasons. Replacement parts have been ordered, and the checkout of the oven is scheduled for September 8, 2009. The testing period for the superalloy disks is expected to last a couple of weeks, following successful calibration of the oven. While ARMD still expects performance consistent with a green rating and completion of milestone before September 30, 2009. However, since the analysis to support the APG will not be complete until after October 1, 2009, ARMD supports a rating of Yellow.

Plans for achieving APG 9AT2: The test will proceed as planned and analysis will be conducted and completed in the first quarter of FY 2010.

Outcome 3E.2: By 2016, develop and demonstrate future concepts, capabilities, and technologies that will enable major increases in air traffic management effectiveness, flexibility, and efficiency, while maintaining safety, to meet capacity and mobility requirements of the Next Generation Air Transportation System.

NASA research addresses the NextGen needs for the movement of aircraft both in the air and on the ground. For airborne aircraft traffic management, NASA researchers, in collaboration with the University of California at Santa Cruz, successfully demonstrated a prototype separation-assurance system. Separation assurance in the context of air traffic control means maintaining legal separation requirements between aircraft. In real-time simulations, ground-based automation was able to maintain safe separation for the entire Fort Worth Center airspace above 10,000 feet. Traffic demand was increased up to twice that of today's levels, and researchers found system performance to be comparable to or better than today's levels. At critical merge points in transition airspace, where demand exceeded capacity, the system efficiently sequenced and spaced aircraft for arrival. Modeling uncertainties included wind, aircraft performance and trajectory intent. The results of the simulations will be published at a professional conference next year.

FY06	FY07	FY08	FY 2009
Green	Green	Green	Green

For the management of surface aircraft traffic (i.e., airplanes taxiing on airport runways) NASA, in a collaborative effort with a team of universities and industry partners, developed and conducted initial evaluations of surface optimization technologies to allow for increased efficiency and capacity in the presence of uncertainties (e.g., gate delays and aircraft sequence changes, etc.). These technologies offer the potential of helping to meet the NextGen capacity improvements in the airport environment. Researchers developed and integrated concepts and algorithms to improve operations of airport surface traffic including ramps, taxiways, and runways. NASA and its partners demonstrated the effectiveness of the optimization technologies in simulations representing two major U.S. airports: Detroit Metropolitan Airport and Dallas-Fort Worth Airport. Using these surface tools, the teams demonstrated an increase in capacity of up to 1.5 times the current traffic levels, with no significant increase in taxi delays. Researchers included infrequent activities such as de-icing aircraft in the assessment to demonstrate the robustness of these tools. The teams assessed environmental benefits for emissions and fuel burn for the proposed framework of surface operations and developed environmental algorithms to ensure that environmental constraints become part of the overall surface traffic-planning scheme.

FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
Complete trajectory analysis for service provider-based automated separation assurance with time-based metering with 2-3 times increase in capacity without reduction of baseline metering accuracy or separation violations.	None	None	8AT05 Green	9AT5 Green
Develop algorithms to generate robust, optimized solutions for surface traffic planning and control. Evaluations will include benefits in both nominal and off-nominal conditions under increased Airportal traffic density and consider environmental constraints and aircraft operator schedule preferences.	None	None	None	9AT6 Green

Outcome 3E.3: By 2016, develop multidisciplinary analysis and design tools and new technologies, enabling better vehicle performance (e.g., efficiency, environmental, civil competitiveness, productivity, and reliability) in multiple flight regimes and within a variety of transportation system architectures.

The Subsonic Fixed Wing project is conducting both laboratory and field experiments to evaluate the efficacy of new synthetic fuels and bio-fuels for aviation applications. As part of this effort, NASA partnered with the Department of Defense (DoD), Environmental Protection Agency (EPA), and Federal Aviation Administration (FAA) to examine the performance and emissions of NASA's Dryden Flight Facility DC-8 aircraft as its inboard engines burned standard Jet Propulsion (JP)-8 fuel or one of the four synthetic test fuels: a fuel prepared from natural gas; an fuel made from coal; and a 50:50 blend of each fuel with the JP-8 fuel. Researchers found that burning Fischer-Tropsch (FT) fuel did not affect engine performance, but did lead to aircraft and storage tanker fuel leaks due to seal shrinkage from exposure to the synthetic test fuels. The most profound effect of the synthetic fuels, however, was the reduction of engine black carbon and mass emissions by more than

FY06	FY07	FY08	FY 2009
Green	Green	Green	Green

75 percent, relative to the JP-8 fuel, across the full range of engine powers. The FT fuels also reduced hazardous air pollutant emissions and the formation of volatile aerosols in the test engine's exhaust plume.

The Subsonic Fixed Wing project embarked on a new research campaign to investigate open rotor (a modified turbofan engine, with the fan placed outside of the engine nacelle) propulsion in collaboration with General Electric Aviation for the next generation of commercial passenger aircraft. This new test campaign will investigate a series of propeller fan blade designs to determine the potential fuel burn reduction that can be achieved with open rotor propulsion. Current estimates show that open rotor propulsion could save ten percent in fuel compared to current turbofan engine technology, and ultimately up to 25 percent with advanced designs.

The Subsonic Rotary Wing project successfully conducted a test of an individual blade control system in collaboration with the U.S. Army, Sikorsky Aircraft, and ZF Luftfahrttechnik GmbH. This was an important test in order to evaluate an Individual Blade Control (IBC) system for its ability to reduce noise and vibrations, and improve the performance of the rotor system. All major test objectives were met, allowing for the evaluation of IBC effects on power, noise, vibration, and loads and flight characteristics.

The Supersonics project completed the Life and Nozzle Change Effects on Tail Shocks (LaNCETS) flight experiment campaign. The primary purpose of this research is to validate computational tools that predict the effect of jet plumes on shock waves that cause sonic booms in supersonic aircraft. Researchers obtained flight data to improve and validate design tools for sonic boom reduction. This improved methodology has led to improved predictions for flight conditions, which is an important step toward designing tools that can enable the design of aircraft with significant sonic boom signatures.

The Hypersonics project completed the first ever, successful flight test of an inflatable reentry vehicle, known as IRVE. The inflatable reentry vehicle aeroshell, a protective skin for the vehicle designed to prevent it from burning up during reentry, is folded into a cylinder on top of a sounding rocket that was launched from NASA's Wallops Flight Facility. The sounding rocket soared to about 130 miles in altitude, deployed IRVE, which then unfolded, inflated and reentered Earth's atmosphere. The flexible fabric-covered aeroshell successfully survived the heat of reentry at Mach 5.5, and decelerated to subsonic speeds while maintaining aerodynamic stability. Inflatable vehicles are a viable new technology for landing large payload masses on other planets such as Mars.

FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
Develop a database for alternative hydrocarbons using accepted testing standards, then characterize the fuels (freezing point, break point, etc) in comparison to current Jet-A.	6AT8 White	None	8AT07 Green	9AT7 Green
Develop and validate transmission tools and technologies to support variable speed drive systems using data from several transmission test cells at GRC.	None	7AT4 Green	8AT09 Green	9AT8 Green
Demonstrate an adjoint-based design method for configuration shaping; also establish the capability to design and analyze supersonic vehicles that achieve efficiency improvements within 10% of the defined targets including engine plume effects and verify the results using wind tunnel and flight experiments.	None	None	8AT11 Yellow	9AT9 Green
Complete the CFD pretest predictions of performance and operability of a high Mach fan for a TBCC propulsion system and compare to fan test data from the GRC W8 facility.	None	None	None	9AT10 Yellow

Why NASA did not achieve APG 9AT10: NASA completed an extensive test program for the fan of a Mach 4 turbine engine. Researchers used the data from this effort to validate NASA's advanced Computational Fluid Dynamics (CFD) codes for turbine analysis and to validate the NASA and General Electric design methodology. All of the stall margin points, with the exception of one, were well within the APG's Green criteria of a five-percent difference. However, the predictions were outside the pre-established metric. The NASA effort to develop Mach 4 turbine engines is a very significant and challenging advancement to the state-of-the-art. The efficiency goal set by the NASA team of 0.25 percent, is very aggressive, especially considering that this was the first attempt at such predictions for a Mach 4 design. Typical efficiency errors for less complex fans are usually in the range of 0.4 percent to one percent, which is consistent with the results from this high-speed test.

Plans for achieving APG 9AT10: The primary reason that the goal was not met is that NASA set very aggressive metrics, especially for the efficiency predictions. This was done to push the limits of NASA's ability to predict challenging conditions, and should not be interpreted as a failure of the prediction methods. NASA will continue to investigate how prediction capabilities can be improved, based on an analysis of the results and comparison with

other state-of-the-art prediction methods on less sophisticated fans. This initial set of experiments and predictions were successful and work is proceeding on more complex testing that permits additional advances. The overall turbine-based combined cycle (TBCC) effort continues with the installation and testing of the TBCC inlet system in the Glenn Research Center 10-by-10-foot Supersonic Wind Tunnel in FY 2010.

Outcome 3E.4: Ensure the continuous availability of a portfolio of NASA-owned wind tunnels/ground test facilities, which are strategically important to meeting national aerospace program goals and requirements.

In FY 2009, the Aeronautics Test Program (ATP) developed a five-year Strategic Plan to ensure the continuous availability of a portfolio of NASA-owned wind tunnels and ground test facilities, which are strategically important to the Nation.

FY06	FY07	FY08	FY 2009
None	None	Green	Green

ATP continued to work with NASA Centers to establish and refine a clear, consistent, and equitable pricing structure and charging policy for wind tunnel testing across the Agency. This approach not only helps cover the cost of operations, it also assists test customers in their cost estimating activities and long-range test planning. ATP also instituted new pricing structures for the use of ATP test capabilities at Dryden Flight Research Center (DFRC), specifically for use of the Western Area Test Range and support aircraft. Fees collected by DFRC for ATP capabilities are used to pay for sustainment and upgrades of ATP test systems.

As part of its efforts to improve facility operational efficiencies, ATP continued to establish the National Force Measurement Technology Capability, to address the severe erosion of NASA's capability to use balances in wind tunnel testing. A balance system measures aerodynamic forces and moments imparted to models during wind tunnel testing. During FY 2009, ATP staff co-authored a technical paper highlighting the issue and the ATP strategy for restoring the national capability in this area. The paper was presented at the 47th annual American Institute of Aeronautics and Astronautics (AIAA) Aero-Sciences Conference in January 2009. ATP is collaborating with the Department of Defense (DoD) communities of practice in this initiative, standardizing and developing a best-practices guide, re-capitalizing the NASA strain-gage balance inventory, and increasing research and development investment in critical force measurement technologies and capabilities.

ATP worked with several national organizations and sponsored or co-sponsored several working group meetings to promote the National Aeronautics Research and Development Policy and to foster effective partnerships and working relationships.

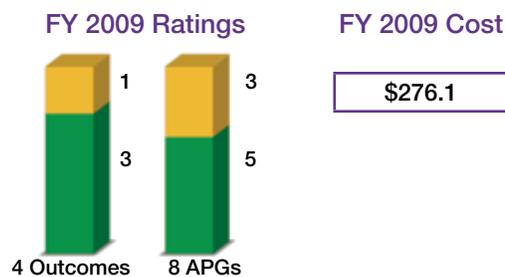
NASA representatives also attended the fourth and fifth National Partnership for Aeronautical Testing (NPAT) council meetings convened in Alexandria, Virginia, and Washington, D.C. The NPAT council is working to establish a foundation for a national aeronautics testing facility strategy.

Also in FY 2009, in collaboration with USAF Arnold Engineering Development Center, the Air Force Research Laboratory, and under the guidance of NPAT, ATP launched a new strategic initiative related to U.S. Aeronautics Ground Test Technology Programs and Requirements. A Ground Test Session was held addressing this initiative at AIAA in January 2009. Proceedings of this meeting will help form the basis for an NPAT vision on test technology.

FY 2009 Annual Performance Goal	FY06	FY07	FY08	FY 2009
To sustain the required aeronautics test facilities force measurement capability for the nation, implement a centralized force balance capability by FY 2009.	None	None	None	9AT11 Green

Sub-Goal 3F

Understand the effects of the space environment on human performance, and test new technologies and countermeasures for long-duration human space exploration.



When astronauts return to the Moon and journey to other destinations in the solar system, they will be subjected to the microgravity, radiation, and isolation of space for long periods of time. To keep crews physically and mentally healthy during long-duration missions requires new technologies and capabilities. Through a combination of ground- and space-based research, NASA is studying how the space environment, close quarters, heavy workloads, and long periods of time away from home contribute to the physical and psychological stresses of space exploration. NASA is developing innovative methods and technologies that can prevent or mitigate the effects of these stresses and to meet the basic needs of astronauts—oxygen, water, food, and shelter—with systems that can operate dependably for weeks on the Moon and, eventually, for months on Mars.

Benefits

The medical knowledge and diagnostic, preventative, rehabilitative, and treatment technologies NASA uses to keep humans healthy and productive in space can improve the medical treatment and health of humans on Earth. For example, NASA's research into human adaptation to microgravity has helped scientists better understand the changes that come with aging, such as bone loss, muscle atrophy, and loss of balance. NASA-developed telemedicine technologies, which help doctors on Earth monitor and treat astronauts in space through a combination of computer-assisted imaging and diagnostics, video, and telecommunications. These same technologies also help doctors deliver quality care to people in isolated or underserved areas of the world. Further, they allow doctors located thousands of miles apart to collaborate in real time on medical treatment.

Over the years, companies have taken NASA life-support and medical technologies, produced by this and other NASA programs, and have developed them into commercial products that serve the public. Light-emitting diodes, originally designed to grow plants in experiments aboard the Space Shuttle, are now used to treat brain tumors. Devices built to measure the astronauts' equilibrium when they return from space are widely used by major medical centers to diagnose and treat patients with head injuries, stroke, chronic dizziness, and central nervous system disorders. A company turned a small, portable device originally designed to warn Space Shuttle and International Space Station (ISS) crewmembers of depressurization into a hand-held device that warns pilots, mountain climbers, skydivers, and scuba divers of hazardous conditions before depressurization and hypoxia become a health threat. For more information on NASA technology transfer successes, please visit the Spinoff home page at www.sti.nasa.gov/tto/.

Risks to Achieving Sub-goal 3F

A major challenge in completing all the planned experiments for long-duration space flight is the availability of flight opportunities to conduct research on crew and associated systems.

FY 2010 Performance Forecast

- The ISS Medical project (ISSMP) will provide planning, integration, and implementation services for NASA's Human Research Program (HRP) research tasks and evaluation activities requiring access to space or related flight resources on the ISS, Shuttle, Soyuz, Progress, or other spaceflight vehicles and platforms. It will support experiments during six-crew operation, develop alternative sample preservation techniques to reduce downmass requirements, and enable cooperative science with Russian collaborators.
- The Research Infusion projects will continue using the NASA Space Radiation Laboratory to evaluate the increased risk of cancer as a function of age, age at exposure, radiation quality, latency, and gender. In

addition, space radiation research will increase efforts to evaluate central nervous system and degenerative tissue risks as well as develop computational tools to project health risks and evaluate vehicle designs for radiation protection.

- HRP also will use ground-based analog and ISS flight-based studies to evaluate contributing factors to health or performance degradation, errors, or failures during critical mission operations. These studies will evaluate sleep loss and circadian rhythms, medication side effects, fatigue, team cohesion, and training protocols. Additional studies will be performed to reduce both the crew health risks during exploration missions and long-term health risks afterward, including cardiac structure and function, stability of pharmaceuticals and nutrients in a space environment, development of a food system that meets all nutrition requirements for long-duration missions, and bone demineralization monitoring techniques.
- Ongoing technology activities will allow NASA to meet the level of care standards for space exploration missions including: medical kit requirements, medical-grade water production system, ventilation system that uses cabin oxygen instead of stored oxygen, capability to analyze blood and saliva-borne biomarkers, and tools for medical decision-making during exploration missions.
- The ISS Research project will deliver two fluid physics and two life science payloads for launch to ISS, as well as conduct four microgravity research experiments onboard the ISS, and one life science experiment on a free-flyer, which is an unmanned spacecraft used to conduct experiments in space biology and physics.



Credit: NASA

NASA astronaut Nicole Stott, Expedition 20 flight engineer, exercises on the Treadmill Vibration Isolation System in the Russian Zvezda Service Module of the ISS. A bungee harness keeps her in place. Regular exercise is critical for preventing muscle atrophy and bone loss while in microgravity. The treadmill is just one of many technologies that keep astronauts healthy during space exploration.

Outcome 3F.1: By 2008, develop and test candidate countermeasures to ensure the health of humans traveling in space.

HRP and the Exploration Technology Development Program (ETDP) will enable long-duration human space missions through their efforts to understand and lessen the harmful effects of the space environment on humans, and by developing new technologies that reduce mission resource requirements.

FY06	FY07	FY08	FY 2009
Green	Green	Green	Yellow

Renal (or kidney) stone formation is a significant risk during long-duration space missions and could impair astronaut functionality. NASA's Renal Stone experiment tests the effectiveness of potassium citrate in preventing renal stone formation during long-duration spaceflight. Researchers presented the results from the Renal Stone Risk During Spaceflight: Assessment and Countermeasure Validation experiment to the Human System Risk Board (HSRB) in November 2008. In addition to hydration and dietary recommendations, researchers recommended potassium citrate as an operational countermeasure based on the results from the in-flight study. The HSRB agreed. Following an operational readiness review by the Office of the Chief Health and Medical Officer (CHMO), NASA approved potassium citrate for medical operational use in June 2009.

Extravehicular activity (EVA), also known as a spacewalk, is any activity performed by astronauts outside their spacecraft. NASA completed an analysis on a new EVA spacesuit measuring the weight, pressure, center of gravity, and mobility. The analysis delivered biomechanics data from Integrated Suit Tests, along with integrated parabolic flight studies, with the principal objective of evaluating candidate technologies under a relevant environment. NASA completed data collection for the Integrated Suit Test in May 2009. The research results were used to update Constellation Program Human-Systems Integration Requirements for development of the next generation lunar surface suit.

Why NASA is not on track to achieve Outcome 3F.1: The Lunar Analog Bedrest Pilot Study (LAPS), a 21-day bed rest study designed to simulate the effects of living on the Moon, was delayed in September 2008 because Hurricane Ike prevented access to the facility.

Plans for achieving 3F.1: LAPS resumed operations in April 2009, with the final subject finishing the study in August. Project researchers completed analysis of the data in September. LAPS Phase 2 will commence in November 2009 with completion in May 2010. With completion of this project, and APG 9AC5, Outcome 3F.1 will be back on schedule.

FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
Develop an operational protocol that meets the standards of the Office of the Chief Health and Medical Officer for a countermeasure to lower the risk of renal stone formation due to increased bone loss during long duration missions in microgravity to below 1%.	6HSRT9 Yellow	7HSRT1 Green	8AC05 Yellow	9AC4 Green
Validate a ground analog fractional-gravity test methodology to assess whether 1/6th g is protective of physiological systems, including bone loss, and if not, what countermeasures are needed.	None	None	8AC06 Green	9AC5 Yellow
Provide recommendations for optimized EVA suit weight, pressure, center of gravity and kinematics.	None	None	None	9AC6 Green

Why NASA did not achieve APG 9AC5: This APG relied on completion of LAPS, which was delayed because Hurricane Ike prevented access to the facility.

Plans for achieving 9AC5: LAPS resumed operations in April 2009, with the final subject finishing the study in August. Project researchers completed analysis of the data in September. LAPS Phase 2 will commence in November 2009 with completion in May 2010.

Outcome 3F.2: By 2010, identify and test technologies to reduce total mission resource requirements for life support systems.

Long-duration human space missions will require large amounts of fresh water and will naturally generate large volumes of wastewater from normal activities. Recovering potable water from wastewater is essential to reducing the mass and cargo requirements for long-duration space missions. NASA is studying three distillation technologies that may increase the amount of water that can be recovered in a closed-loop system, thereby decreasing the amount of water necessary for long-duration missions.

FY06	FY07	FY08	FY 2009
Green	Green	Green	Green

Evaluations of two of the three alternative distillation technologies are complete and the third is in process. Testing of the Cascade Distillation System (CDS) and Vapor Compression Distillation (VCD) were completed in August 2009. Shipment of the third system, the Wiped Film Rotating Disk (WFRD), was delayed because of manufacturing difficulties, but is currently on track for delivery and test completion by October 13, 2009 (after the end of the fiscal year). Despite the small delay with the third system, this Outcome is on track to be completed by 2010.

FY 2009 Annual Performance Goal	FY06	FY07	FY08	FY 2009
Evaluate three alternative distillation technologies for primary water processing as part of closed loop water recovery systems.	None	None	None	9AC7 Yellow

Why NASA did not achieve APG 9AC7: NASA did not complete the evaluation of the third alternative distillation technology by the end of September 2009 because of manufacturing difficulties.

Plans for achieving 9AC7: The NASA will complete the testing by October 13, 2009. The final report comparing the three technologies will be completed by the first quarter of FY 2010.

Outcome 3F.3: By 2010, develop reliable spacecraft technologies for advanced environmental monitoring and control and fire safety.

NASA uses biocides, chemicals that prevent harmful bacteria growth, in the recycled water used for long-duration space missions to keep the crew's water safe. However, these biocides usually need to be filtered out of the water before drinking. The Colorimetric-Solid Phase Extraction (C-SPE) instrument will enable ISS astronauts to quickly and easily determine the biocide levels in their water, both before and after the biocide-filtration process. Since the C-SPE was built to test the new water recycling system on the ISS, the instrument was not required to complete a System Design Review. Instead, the ISS Safety Review Panel reviewed the test mission and approved it for flight on April 29, 2009. The instrument launched on the STS-128 mission.

FY06	FY07	FY08	FY 2009
Green	Green	Green	Green

FY 2009 Annual Performance Goal	FY06	FY07	FY08	FY 2009
Complete the System Design Review for the Colorimetric Solid Phase Extraction Water Biocide Monitor.	None	None	None	9AC8 Green

Outcome 3F.4: By 2012, identify and develop tools, methods, and technologies for assessing, improving and maintaining the overall health of the astronaut corps, for mission lengths up to 180 days in microgravity or 1/6 G.

For FY 2009, NASA's Crew Health and Safety Program (CHSP) achieved or made progress on all of its annual performance goals. In addition, CHSP installed ultrasound units and software in its clinic to do Carotid Intima-Media Thickness assessments to aid in cardiovascular screening. These assessments will permit better and earlier identification of cardiovascular issues in crewmembers. CHSP also created a data repository to assist in workflow and management of mission medical information. This collection of information will build efficiencies into current practices and allow rapid and more accurate management of medical issues as they arise.

FY06	FY07	FY08	FY 2009
None	None	None	Green

FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
Publish volume 5 of the Spacecraft Maximum Allowable Concentrations (SMACs) and volume 3 of the Spacecraft Water Exposure Guidelines (SWEGs).	None	None	None	9SFS1 Green
Thirty-seven percent of current and former astronaut medical requirements data will be captured in a comprehensive medical data management infrastructure.	None	None	None	9SFS2 Green
Capture 100% of medical and environmental data required by Medical Operations in queryable form.	None	None	None	9SFS3 Yellow

Why NASA did not achieve APG 9SFS3: Capturing the relevant data is an information technology-based task. The resources necessary to accomplish this task were diverted to work on the Homeland Security Presidential Directive 12 requirement for common identification standards across the Federal government. The action only impacts the timeframe for completion.

Plans for achieving 9SFS3: CHSP plans to continue with the original set of activities, but with a five-month slip in schedule. The completion date will be the second quarter of FY 2010 rather than the fourth quarter of FY 2009.

Strategic Goal 4

Bring a new Crew Exploration Vehicle into service as soon as possible after Shuttle retirement.



Strategic Goal 4 is essential to achieving NASA's Mission. The Nation's current space transportation system, the Space Shuttle, is not designed for human exploration beyond low Earth orbit. To achieve the long-term objective of returning explorers to the Moon and eventually sending them to Mars, NASA initiated the Constellation Program. The program is responsible for the projects that will design, build, and test the Orion Crew Exploration Vehicle, the expendable crew launch vehicle Ares I, the heavy-lift cargo launch vehicle Ares V, and spacesuits and tools required by the flight crews, and to create, or transition from the Space Shuttle Program, associated ground and mission operations infrastructure to support initial low Earth orbit missions.

Orion will be America's new spacecraft for human space exploration. It will carry four crewmembers to the Moon and serve as the primary exploration vehicle for future missions. It also will be capable of ferrying astronauts and cargo to and from the International Space Station (ISS), if commercial transport services are unavailable. The Ares I will consist of a solid rocket booster and an upper stage that can carry Orion into low Earth orbit.¹¹

Benefits

Orion will support the expansion of human exploration missions and provide the means to take humans to the Moon where they can conduct scientific activities and make discoveries that cannot be achieved solely with robotic explorers.

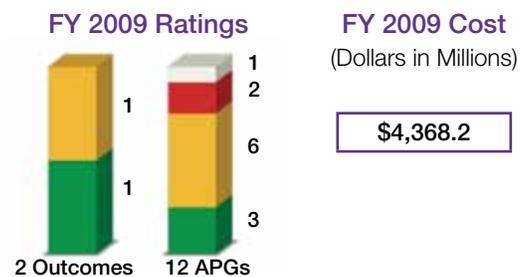
As with past and current human exploration programs, NASA's efforts to develop Orion and the Ares launchers will accelerate the development of technologies that are important for the economy and national security. The advanced systems and capabilities required for space travel include power generation and storage,

communications and navigation, networking, robotics, and improved materials, all of which could be used on Earth to meet commercial and other national needs. As Shuttle activities wind down, Shuttle personnel will find new, challenging positions working on Constellation development efforts, keeping this highly skilled segment of America's workforce productive and competitive. Constellation also will provide a training ground for the next generation of scientists and engineers who will realize the Nation's space exploration dreams.

Furthermore, Orion will serve as a public symbol of the Nation's continued commitment to space exploration, much as the Shuttle has for over 25 years. NASA anticipates that the exploration initiatives will spark the public's imagination and inspire the Nation's youth to pursue careers in science, technology, engineering, and mathematics as a result of their renewed interest in space.

Risks to Achieving Strategic Goal 4

The Constellation Program is striving to meet challenges in the management and technical areas. The Constellation Program must manage its development work to ensure it remains within a constrained budget while also meeting the externally committed milestones of exploration. In the technical arena, the Constellation Program has some engineering challenges very similar to many NASA encountered during the Apollo Program and development of the Space Shuttle. Every time NASA faces an engineering challenge, Agency engineers examine all the options for addressing the issue. NASA has an excellent track record of resolving technical challenges and the Agency expects to resolve any technical issues and meet the Exploration Systems milestones.



¹¹For more information on NASA missions, please see NASA's Missions at a Glance, located in the *Other Accompanying Information* section of this document.

FY 2010 Performance Forecast

As the budget request for FY 2011 takes shape, NASA awaits direction from the White House and Congress on the ongoing plans for the Constellation Program.

The Orion project plans to enter development, and Constellation plans to begin building the spacecraft that will carry up to four astronauts to low Earth orbit. Orion will be capable of ferrying astronauts to the ISS or linking up with a lunar lander for a trip to lunar orbit.

Constellation will continue work on the Ares I launch vehicle that will launch the Orion spacecraft. The program will focus on establishing the requirements for Ground Operations and Mission Operations, preparing both projects to enter their implementation phase.

The Space Operations Mission Directorate's Rocket Propulsion Test Program has established testing requirements for Constellation that will be used to identify excess and "at risk" test facilities, and the program will support decisions relative to test asset consolidation initiatives.



The Ares I-X rocket stands tall inside NASA Kennedy Space Center's Vehicle Assembly Building Bay 3 on September 25, 2009. Part of the Constellation Program, the Ares I-X is the test vehicle for the Ares I, which is the core of NASA's new space transportation system. The Ares I-X flight test occurred in October 2009.

Credit: NASA /K. Shiflett

Outcome 4.1: No later than 2015, and as early as 2010, transport three crewmembers to the International Space Station and return them safely to Earth, demonstrating an operational capability to support human exploration missions.

The recently completed Augustine Committee report's analysis of the Constellation program found that "there is likely an additional delay of two years, with first launch in 2017, and perhaps as much as four years of delay, with first launch in 2019." NASA has not yet fully integrated the Augustine Committee's finding with the program's cost and schedule estimates. NASA does consider the schedule a high-risk item. The program is in the midst of the schedule assessment, for which the Augustine panel's data is an important indicator.

FY06	FY07	FY08	FY 2009
Green	Yellow	Yellow	Yellow

During FY 2009, the Constellation Program received approval from NASA to move to the next phase within the program life cycle, implementation. During implementation, the program's constituent projects are assigned to NASA Centers or awarded through competition, and the program manages the projects throughout their life cycle. The Constellation Program also completed the Preliminary Design Review (PDR) for the Orion project. This review confirms that the preliminary vehicle design meets all system requirements, and does so with acceptable risk and within the cost and schedule constraints. The PDR review also established the basis for developing a detailed design. NASA replanned the program funds and schedule, moving key program and project review milestone dates. While this earns NASA a Yellow rating for Outcome 4.1 for FY 2009, the revised schedule is more achievable and should help the program get its projects back on track to achieve this Outcome in coming years.

In March 2009, NASA began the Post-landing Orion Recovery Test (PORT) at a U.S. Navy test facility to determine what kinds of motions astronauts can expect after the Orion spacecraft returns to Earth and lands in the water, as well as the conditions in which the recovery team will work. PORT moved to the Kennedy Space Center in April, where the team could work with the mockup in the open waters off the coast of Port Canaveral. More information on the March testing is available at www.nasa.gov/exploration/features/OrionPORT.html.

When the Orion spacecraft makes return flights from space, decelerating as it drags through Earth's atmosphere, it will encounter temperatures as high as 5,000 degrees Fahrenheit. The thermal protection system, or

Project Review 101

The **PDR** demonstrates that the overall project preliminary design meets all risk, cost, and schedule requirements.

KDP-C is where NASA decides if the project can enter Phase C (development), where the project builds, tests, and integrates all sub-systems and systems. At this point, the project sets its life-cycle cost and schedule baseline, as well as any technical and scientific goals.

The **CDR** demonstrates that the project's design can proceed with full-scale fabrication, assembly, and integration and that it is within the identified cost and schedule.

heat shield, along the curved underside of the capsule will protect Orion and its crew from these extreme temperatures. NASA has developed two materials, PICA and AVCOAT, for the Orion heat shield and qualified their ability to withstand extreme cold and heat using a variety of testing. In April, the Constellation Program chose the AVCOAT material, while continuing to develop the PICA material as a backup. More on the PICA and AVCOAT tests is available at www.nasa.gov/mission_pages/constellation/orion/orion-tps.html.

The Constellation Program has been testing elements of the Ares I, which will launch the Orion spacecraft to low Earth orbit, in preparation for the rocket testing that will take place in early FY 2010. On September 10, NASA and ATK Space Systems completed the first successful test firing of the Ares I rocket's first-stage development motor, or DM-1. More on the DM-1 and the test firing is available at www.nasa.gov/mission_pages/constellation/ares/dm1_success.html.

NASA's Exploration Web site provides the latest news and features about Orion, the Ares space launch vehicles, and related exploration technologies and capabilities: www.nasa.gov/exploration/home/index.html.

Why NASA is not on track to achieve Outcome 4.1 as stated: As with any major development program in formulation, the Constellation Program continues to perform detailed budget and schedule analysis to ensure that each project's budget and content are optimized to successfully meet the March 2015 Initial Operation Capability (IOC). During the FY 2010 Budget Request cycle, NASA did a replan, which resulted in the realignment of some major milestones. This resulted in a delay in some major milestones reflected in the yellow rating of several FY09 APGs, but preserved the March 2015 IOC date. NASA is currently in the process of reviewing its latest cost and schedule confidence in advance of the Key Decision Point (KDP)-II, which will move the program into the Implementation phase.

Plans for achieving Outcome 4.1: In summer 2010, NASA will hold Ares I, Orion, and Ground Operations Key Decision Point C reviews to decide if each are ready to enter development. At this time, Constellation also will go through its second KDP review, allowing the program to enter implementation. The Mission Operations and Extravehicular Activity (EVA) projects will have their PDRs, preparing them for their KDP-C reviews. Additionally, Constellation made significant progress in understanding and integrating project interdependencies, allowing for improved integration of scheduling and helping the program get back on track to achieve the Outcome.

FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
Complete the Critical Design Review (CDR) for the Orion / Crew Exploration Vehicle (CEV).	6CS2 Green	7CS2 Yellow	8CS01 Yellow	9CS1 Red
Complete the Critical Design Review (CDR) for the Ares I Upper Stage (US) element.	None	None	None	9CS2 White
Complete the Critical Design Review (CDR) for the Pad B Launch Complex development within the Ground Operations Project.	None	None	8CS04 White	9CS3 Yellow
Complete the Preliminary Design Review (PDR) of the Mission Control Center System (MCCS) within the Mission Operations Project.	None	None	8CS11 Yellow	9CS4 Yellow
Complete the Preliminary Design Review (PDR) for the Extravehicular Activity (EVA) Space Suit Element for CEV.	None	None	8CS06 Yellow	9CS5 Red
Complete the launch and flight analysis of the CEV Pad Abort 1 (PA-1) test.	None	None	None	9CS6 Yellow
Complete the launch and flight analysis of the Ares 1-X sub-orbital test.	6CS3 Green	7CS3 Yellow	8CS02 Green	9CS7 Yellow
			8CS03 Green	
Coordinate rocket propulsion test activities to support Constellation rocket propulsion testing milestones by providing an agency level Rocket Propulsion Test Plan.	None	None	None	9CS12 Yellow
In FY 2009, maintain agency rocket propulsion test core competencies (both infrastructure and critical skills) at appropriate levels to meet Constellation testing requirements and integrate these with other NASA programs, commercial partners, and DoD requirements and capabilities. (This APG was listed as 9SFS3 in FY 2009 Performance Plan Update and is corrected here.)	None	None	None	9SFS4 Yellow
Deliver a prototype 5-meter diameter ablative heat shield for Orion to the Constellation Systems Program.	None	None	None	9SFS9 Green

FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
Deliver a prototype 5-meter diameter ablative heat shield for Orion to the Constellation Systems Program.	None	None	None	9AC11 Green

Why NASA did not achieve APG 9CS1: Constellation established the milestone date used for this APG when the project was still in early formulation. Since then the project's schedule has been refined and the milestone pushed to a later date to align with the Constellation Program's replanned schedule.

Plans for achieving 9CS1: The Orion project has been following the schedule set by the Constellation Program. The project continued to perform Design Analysis Cycles through summer 2009, which led to a successful PDR in July and August. The next major milestone on Orion's schedule is the KDP-C review set for summer 2010. The Orion Critical Design Review (CDR) follows that review in FY 2011.

Why NASA rated APG 9CS2 White: APG 9CS2 should have been written as Upper Stage Engine, not Upper Stage element. When NASA submitted the FY 2009 Budget, internal planning documents reflected the Upper Stage CDR in FY 2010, and the Upper Stage Engine's CDR in FY 2009. The Upper Stage Engine CDR was successfully completed. As a result of incorrect wording for the APG, NASA is unable to rate the activity as relevant to FY 2009 activities. APG 9CS2, as defined, cannot be accurately assessed as the intent of APG is unclear. It is difficult to discern if it refers to the Upper Stage or Upper Stage engine. As such, we cannot conduct an adequate assessment.

Why NASA did not achieve APG 9CS3: The Constellation Program changed the Ground Operations Pad B Launch Complex milestone dates in accordance with the program's revised schedule.

Plans for achieving 9CS3: NASA plans to hold the CDR for the Pad B Launch Complex in summer 2010.

Why NASA did not achieve APG 9CS4: The Constellation Program changed the Mission Operations project's schedule, and the project did not mature the Mission Control Center System to the point where it could undergo the PDR.

Plans for achieving 9CS4: NASA has made it possible for mature subsystems for the Mission Control Center System to proceed with a PDR and then allow those subsystems to begin working toward their CDR. The Mission Operations project will have the entire Mission Control Center System ready for its PDR in summer 2010.

Why NASA did not achieve APG 9CS5: The Constellation Program changed the project's schedule when the program did its replan.

Plans for achieving 9CS5: As part of the Orion PDR, the Constellation Program identified what was required to make the EVA spacesuit design work with the Orion spacecraft systems, and the two projects have integrated their hardware development, associated analyses, and related milestones. The EVA Suit Configuration 1 PDR is scheduled for September 2010, which enables the Constellation Space Suit System prime contractor an opportunity to mature the rest of the system.

Why NASA did not achieve APG 9CS6: Unanticipated difficulties during subscale testing (where the project team test a smaller-scale engineering model) of the Attitude Control Motor (ACM) delayed the Pad Abort-1 (PA-1) flight test.

Plans for achieving 9CS6: Due to the difficulties during testing, the project changed the design. Two successful subscale test firings with the new design indicated that the project has overcome the challenges. A full-scale test firing of the ACM is scheduled for fall 2009, and the Orion project remains on track to conduct the PA-1 test in early 2010. These tests are for a Launch Abort System that will allow the crew to jettison clear of the Ares I rocket in case of emergency before launch. This is a safety feature that has not been available on NASA's previous space transportation systems.

Why NASA did not achieve APG 9CS7: The Ares I-X flight test was delayed primarily due to vendor component manufacturing delays, changes to the availability of Space Shuttle Program assets (see Outcome 4.2), and the complexities of loads analyses and certification.

Plans for achieving 9CS7: The vendors have delivered all the components for the Ares I-X flight test vehicle to Kennedy Space Center, and the vehicle has been stacked. The project is testing the integrated vehicle elements. In May 2009, the Shuttle Program turned over Pad 39B to the Ares I-X team, following the STS-125 Shuttle mission,

and the Ares project began modifying the pad. The flight test occurred in early FY 2010. The project will analyze the flight data and apply it to Ares I computational models, and will continue this task into mid-2010.

Why NASA did not achieve APG 9CS12: Constellation established the milestone date used for this APG when the program was still in early formulation. Since then, the program refined its schedule in preparation for the FY 2011 budget request.

Plans for achieving 9CS12: Constellation’s projects contributing to the flight capability have been realigned to the new schedule. The PDR is scheduled for spring 2010.

Why NASA did not achieve APG 9SFS4: Changes to the Constellation Program’s schedule and the resulting changes in the respective test programs delayed development of the Rocket Propulsion Test Plan.

Plans for achieving 9SFS4: At this time enough information exists to create an appropriate plan. Areas where there are still decisions to be made or revisited will be incorporated in the initial plan or revised in yearly updates. A team lead by a NASA Senior Executive will have a final plan by August 2010, and management for the Space Operations Mission Directorate will review and approve the plan by the end of FY 2010.

Outcome 4.2: By 2010, successfully transition applicable Shuttle components, infrastructure, and workforce to the Constellation Systems program.

Exploration Systems completed the Shuttle’s and the Constellation Program’s personal property and real property requirements. Exploration Systems will present the Constellation Program’s requirements to the Joint Integration Control Board and the Transition Control Board in early FY 2010. The Mission Directorate will work out remaining personal property and real property issues in FY 2010. A full assessment of property needs will ensure that NASA transitions the appropriate property so that the Agency does not end up with unneeded assets or dispose of property that could be used by Constellation.

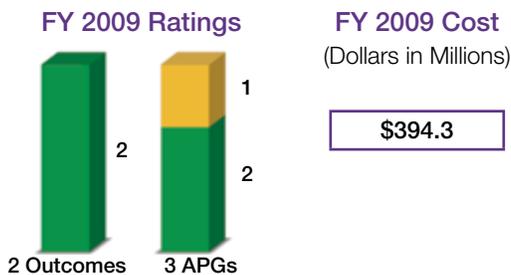
FY06	FY07	FY08	FY 2009
Green	Green	Green	Green

Last fiscal year, NASA began preparing Mobile Launcher Platform (MLP)-1 to carry the Ares I-X. This 4,625-ton, two-story steel structure was originally designed to carry a Shuttle up the gentle slope—keeping it level the entire time—to Kennedy Space Center’s launch complex. On March 25, 2009, NASA handed the modified MLP-1 over to Constellation for use during the Ares I-X rocket testing in early FY 2010, an important step for developing the launch vehicle. In June, Constellation took over the Vehicle Assembly Building High Bay to assemble the Ares I-X into the familiar tall, thin rocket. The Shuttle Program also turned over the Launch Complex-39 Pad B to begin its conversion for the Ares I-X launch. Work on the Launch Pad continued through the summer and into FY 2010. For the test, MLP-1 will carry the stacked Ares I-X, which will stand upright on the platform, out to the converted Launch Pad.

FY 2009 Annual Performance Goal	FY06	FY07	FY08	FY 2009
Demonstrate progress towards the transition of Space Shuttle and Space Station workforce and infrastructure for utilization in Constellation, including the transfer of the Vertical Assembly Building, configuration of Launch Complex 39-B and the Mobile Launch Platform 1 for the Ares 1-X test.	None	None	8CS07 Green	9CS8 Green

Strategic Goal 5

Encourage the pursuit of appropriate partnerships with the emerging commercial space sector.



The objective of Strategic Goal 5 is to acquire launch services and technologies that enable NASA's robotic and human missions. NASA's robotic missions are launched on commercial vehicles acquired through NASA's Launch Services. As the Space Shuttle nears retirement, NASA is interested in International Space Station (ISS) cargo delivery and return services provided by emerging U.S. launch service companies.

Benefits

Since NASA's creation in 1958, the commercial sector has been an important Agency partner in space exploration. NASA purchases launch services for robotic missions from the commercial space sector. NASA works with commercial partners to develop communication and navigation systems, build spacecraft, and design spacesuits. Along the way, the commercial space sector has grown into a multi-billion dollar industry that delivers services, such as satellite television and global navigation, to the public and contributes to a strong U.S. economy.

Historically, several large corporations have dominated the commercial space industry, but now start-up ventures are pushing the industry into new areas. To encourage this emerging sector of the space industry, the Exploration Systems Mission Directorate has adopted a Commercial Development Policy that will be used as a basis for an Agency-level policy. Programs and projects, such as Commercial Orbital Transportation Services (COTS) and Centennial Challenges (both described in more detail below) are examples of this policy already being implemented within the Agency. By helping emerging companies expand their services and increase their experience, NASA hopes to encourage the growth of a competitive market that will help reduce launch costs and provide NASA with access to new capabilities. NASA seeks to stimulate the emerg-

ing U.S. entrepreneurial launch sector and accelerate the growth of the commercial space business by maximizing the industry's ability to retain intellectual property rights and by awarding prizes for achievements in creating space technologies and systems.

NASA also is encouraging the emerging U.S. commercial space sector with more creative, less traditional approaches. In FY 2006, NASA selected a portfolio of two emerging aerospace companies to demonstrate orbital cargo transportation services through the COTS project. The Agency later added to its portfolio by signing unfunded Space Act Agreements with other companies.

Since FY 2005, NASA has held prize competitions, called Centennial Challenges, for ground-based demonstrations of breakthroughs in various aerospace technologies. Although there is no guarantee that a breakthrough or winner will emerge from any particular prize competition, by encouraging participation, NASA hopes to encourage private sector breakthroughs across a broad range of technologies and designs.

Risks to Achieving Strategic Goal 5

Using new launch systems presents potential increased risk to the Agency because the companies' launch systems are unproven. NASA needs to balance the need to encourage emerging companies against the need to carry out Agency missions with limited risk. In 2007, the Launch Services Program (LSP) completed an Agency strategic review of options for expendable launch vehicles in the medium performance class. A key recommendation accepted by the Agency is to give significant attention to enabling the emerging systems in becoming certified for NASA use. LSP also coordinated an Agency review of NASA Policy Directive 8610.7 "Launch Services Risk Mitigation Policy for NASA-Owned and/or NASA-Sponsored Payloads/Missions" to evaluate the feasibility of changing Agency policies, and thereby enable the use of emerging launch service providers sooner. The policy elements reviewed included the number of demonstrated successful launches required for certification, and was modified to eliminate the require-

ment for the launch service provider to have a previously certified launch vehicle under certain certification alternatives. The policy mitigates risk by balancing the level of NASA technical insight into the launch systems with demonstrated launch success. These changes recognize the current industry market and the steps that are required for certification. There is no guarantee that new providers will be ready and certified when needed for NASA missions.

The successful implementation of commercial services involves detailed technical work needed to successfully integrate private sector vehicles and NASA systems. With funded and unfunded partners onboard for the COTS project, NASA and its partners are working closely to ensure that the communications, docking or berthing, operational, and navigational interfaces are well planned and the technical requirements well understood. In addition, the commercial partner services must prove, through the ISS safety panel process, that their system is sufficiently safe enough in order to be allowed to approach the station.

Another challenge is that the commercial space market remains weak, suppliers continue to struggle, and costs continue to rise, as evident by the failure of one of NASA's funded partners to perform in accordance with their Space Act Agreement, resulting in their subsequent termination. The loss of a partner narrows the field of options for success, thus NASA conducted a competition in early FY 2008 to bring on an additional funded partner or partners.

NASA faces issues with all classes of launch services. Small class missions may have competition and will struggle for cost effective launch services. There are no near-term replacements for medium class launch services and while the COTS effort may bring future launch capability, satellite constellation replenishments such as ORBCOMM, Iridium, and Globalstar will not likely be supplied by U.S. launch service providers.

FY 2010 Performance Forecast

- LSP will manage the successful commercial launch of three planned mission launches for FY 2010: WISE, SDO, and Aquarius. LSP will also provide advisory services for GOES-P.
- The Rocket Propulsion Test (RPT) program will continue to test facility management, conduct maintenance, and sustain engineering, operations, and facility modernization projects required to keep the test-related facilities in the appropriate state of operational readiness and will continue to be funded. Established testing requirements for the exploration program will be used to identify excess and "at-risk" test facilities and will support decisions relative to test asset consolidation initiatives. RPT's inventory of 32 test stands, ranging from active to mothballed facilities, will continue to be maintained at various states of operational readiness as required. Propulsion test technology development will also be continued.
- The Commercial Crew and Cargo Program Office (C3PO) will focus on the successful continuation of the Space Act Agreements of the COTS partners, culminating in an orbital flight demonstration by at least one partner and progress being demonstrated by the other funded and unfunded partners.



Credit: SpaceX

SpaceX's Falcon 9 rocket sits on the pad at Cape Canaveral, Florida, in this photo taken in December 2008 (top) and Orbital's Taurus II rocket blasts off from the same pad in an artist's rendition. Both companies are developing their launch vehicles to deliver cargo to the ISS.



Credit: Orbital

Outcome 5.1: Develop and demonstrate a means for NASA to purchase launch services from emerging launch providers.

In FY 2009, NASA's Johnson Space Center issued the ISS Commercial Resupply Services (CRS) contracts, which will guide the LSP evaluation of launch vehicles to be used for the resupply of the ISS. Under one of these contracts, LSP began initial technical exchanges with Space Exploration

FY06	FY07	FY08	FY 2009
Green	Green	Green	Green

Technologies (SpaceX) for the use of the Falcon 9 launch vehicle and Dragon spacecraft, which is designed to carry cargo or people (a feature not optioned under this contract). NASA arranges regular technical exchanges with its contract partners, a process where NASA and the partner share data and the partner can provide updates on the program's progress. This year LSP also established two unfunded Space Act Agreements. One of these agreements is for the second launch vehicle under the CRS contract, the Taurus II, which is being developed by Orbital Sciences Corporation to launch the Cygnus spacecraft, the unmanned spacecraft designed to transport cargo to the ISS. Since the CRS contract does not require deliverables for the Taurus II until FY 2010, LSP established this agreement to begin technical exchanges with Orbital in FY 2009. The second agreement is with Alliant Techsystems Inc. (ATK) for their SLV A and B small launch vehicles. LSP initiated technical exchanges with ATK in FY 2009.

FY 2009 Annual Performance Goal	FY06	FY07	FY08	FY 2009
Establish a contractual mechanism or agreement to provide technical exchanges between NASA's Launch Services Program and emerging launch vehicles/providers to enhance early launch success.	None	7SFS4 Green	8SFS01 Green	9SFS5 Green

Outcome 5.2: By 2010, demonstrate one or more commercial space services for ISS cargo and/or crew transport.

NASA's COTS project is an investment by NASA to spur development of a cost-effective, U.S. commercial capability to carry cargo to the ISS, with future options for transporting crew. The COTS project currently has funded Space Act Agreements with two partners, SpaceX and Orbital Sciences Corporation. SpaceX and Orbital continue to make progress towards Outcome 5.2 by completing several agreed-upon milestones. SpaceX completed three key milestones outlined in the agreement for FY 2009. In December 2008, SpaceX passed the Critical Design Review (CDR) for the second and third demonstration flights to the ISS, clearing the way for the manufacturing and test of flight hardware, software, and ground systems.

FY06	FY07	FY08	FY 2009
Green	Green	Green	Green

In preparation for their service to the ISS, SpaceX delivered the COTS Ultra High Frequency (UHF) Communication Unit (CUCU) to the Kennedy Space Center for launch on *Atlantis* STS-129 mission, scheduled for no earlier than November 12, 2009. ISS and Shuttle crewmembers will integrate the hardware with ISS systems in preparation for when the Dragon spacecraft docks. The UHF CUCU will provide communication between the ISS, SpaceX's Dragon spacecraft, which will operate robotically, and ground-based mission control. The unit allows crew at mission control and aboard the ISS to monitor the spacecraft's progress as it approaches the ISS and communicate with the spacecraft's navigation to adjust its course as it maneuvers to dock.

FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
Have at least three funded and unfunded Partners receiving technical assistance through the COTS Assistance Team (CAT) and making progress toward orbital demonstrations of commercial crew and cargo systems.	None	None	None	9CS10 Green
Have at least one Partner complete a minimum of one orbital demonstration flight in FY 2009.	None	None	8CS08 Yellow	9CS9 Yellow
			8CS09 Green	
			8CS10 Green	

Why NASA did not achieve APG 9CS9: NASA did not meet the stated APG in FY 2009, but is on track to complete it in FY 2010. During FY 2009, SpaceX notified NASA of delays associated with the maiden launch of its Falcon 9 launch vehicle flight, which impacted their ability to maintain the current launch dates for the NASA COTS demonstration missions. SpaceX has replanned its work and has committed to fly all three COTS demonstration missions in 2010. NASA continues to work closely with SpaceX to provide technical assistance and monitor progress.

Plans for achieving 9CS09: The first COTS orbital flight demonstration is now planned for early 2010 and NASA expects that the goals of the program will be met.

Strategic Goal 6

Establish a lunar return program having the maximum possible utility for later missions to Mars and other destinations.



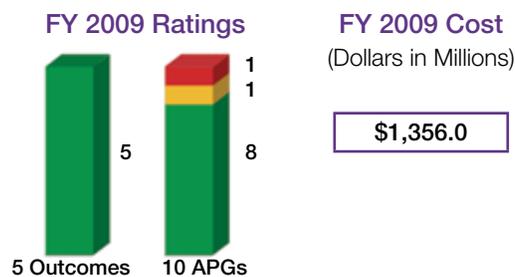
Missions to the Moon in the 21st century will be vastly different from the Apollo missions of the 1960s and 1970s. Future missions will carry more crewmembers, expand the range of lunar landing sites, and increase the length of time astronauts spend exploring the lunar surface. Future explorers will experiment with using lunar resources (e.g., possible water ice located deep within lunar craters) to reduce the amount of supplies that must be brought from Earth and to support an extended human presence on the Moon.

To achieve Strategic Goal 6, NASA is leveraging partnerships with industry and the international space community to acquire next-generation technologies for life support, communications and navigation, radiation shielding, power generation and storage, propulsion, and resource extraction and processing.

NASA is laying the foundation for the lunar return program by focusing Agency research on robotic reconnaissance explorers, surface nuclear power systems, and advanced communications systems. These technologies will support the lunar return program and will evolve and be adapted to support future Mars missions.¹²

Benefits

NASA and the Agency's partners transfer advanced space exploration systems and capabilities—power generation, communications, computing, robotics, and improved materials from space exploration research and execution—to the commercial sector to serve public, national, and global needs. In the past, technologies developed for space exploration have yielded ground-based applications, such as non-polluting solar energy systems, advanced batteries for laptop computers and cell phones, and fuel cells for electric vehicles.



The activities under Strategic Goal 6 lay the groundwork for NASA's future human space exploration goals. With the successful completion of these activities, NASA will have the technologies and capabilities to support humans on the Moon by the time the Orion Crew Exploration Vehicle and the Ares launch vehicles are fully operational. Until then, these activities will benefit other efforts across NASA: new power generation and nuclear technologies will help future space exploration missions; autonomous systems and integrated systems health management can make air travel safer and more efficient; and improved space communications enable better data delivery to and from the Space Shuttle, the International Space Station (ISS), and robotic spacecraft.

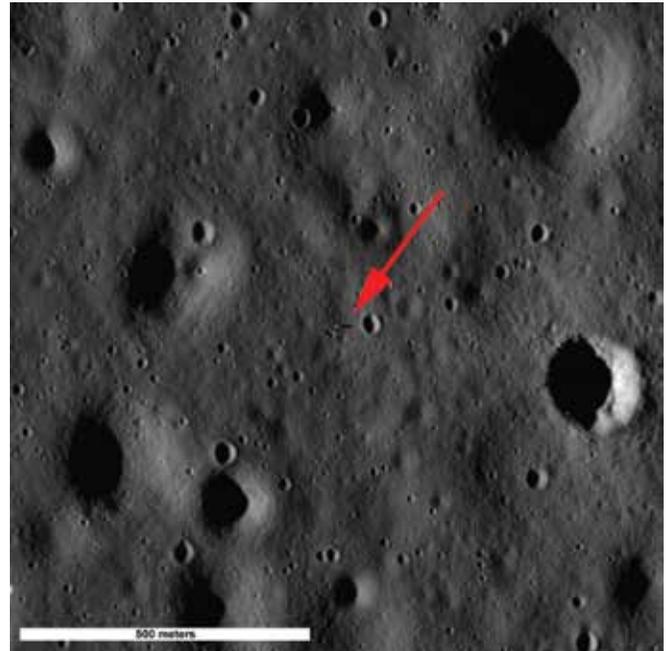
Risks to Achieving Strategic Goal 6

The Advanced Capabilities Theme develops new, advanced technologies for NASA's robotic and human exploration missions. Many of the projects conducted by the Advanced Capabilities Exploration Technology Development Program (ETDP) are either in formulation or early stages of development. As such, they are subject to challenges that affect any project in its early stages:

- Reductions in planned budget may prevent technologies from being matured in time to support preliminary design of flight systems;
- The evolving lunar program architecture may cause technology development priorities to change; and
- Technologies may be more difficult to develop to the required level of maturity than originally anticipated.

¹²For more information on NASA missions, please see NASA's Missions at a Glance, located in the *Other Accompanying Information* section of this document.

Shortly before the 40th anniversary of the Apollo 11 moon landing, LRO took its first pictures of that landing site. The pictures show the Apollo 11 lunar module descent stage sitting on the Moon's surface, as long shadows from a low Sun angle make the module's location evident (indicated by the red arrow). The spacecraft reached lunar orbit June 23, 2009, and imaged five of the six Apollo sites between July 11 and 15. Although LRO team members expected that LRO would be able to resolve the remnants of the Apollo mission, the spacecraft produced these images before the spacecraft reached its final mapping orbit, highlighting the fine resolution of LRO's imaging instruments.



Credit: NASA/Goddard Space Flight Center/Arizona State University

To mitigate these risks, NASA is conducting follow-on studies to the Exploration Systems Architecture Study. Through this process, NASA continues to:

- Adjust the exploration architecture based on budget constraints, technology readiness levels, and probable capabilities;
- Reassess technology needs and refocus research and development based on study findings; and
- Strategically plan for near- and long-term needs, creating a balanced portfolio of medium- to high-maturity technologies required by current missions and higher-risk technologies that may not have immediate mission applications but would enable future missions.

FY 2010 Performance Forecast

- Late in FY 2009, the Constellation Program will convene the operational capabilities Preliminary Design Review (PDR) Board. Instrument and subsystem integration and testing were the primary FY 2008 activities for both LRO and LCROSS, with final preparation for launch late in FY 2009. LCROSS is currently scheduled to complete its mission by the end of the first quarter of 2010 by impacting the lunar surface, investigating the possible presence of water in a permanently shadowed crater.

- The Space and Communications and Navigation Program's (SCaN's) major goals will be to provide support to all missions, conduct the Tracking and Data Relay System (TDRS-K/L) PDR/ Non-Advocacy Review, and deliver the software Defined Radio Test Bed payload to the Space Transportation System for launch in 2010.

Outcome 6.1: By 2008, launch a Lunar Reconnaissance Orbiter (LRO) that will provide information about potential human exploration sites.

To enable a successful return to the Moon, the characteristics of the lunar environment must be understood. The LRO mission will create a comprehensive atlas of the Moon's features to help NASA select landing sites, identify lunar resources, and study the radiation environment. The Lunar Crater Observation and Sensing Satellite (LCROSS), riding along with LRO, will search for the presence of water ice hidden deep in the Moon's craters.

FY06	FY07	FY08	FY 2009
Green	Green	Yellow	Green

LRO and LCROSS successfully launched on June 18, 2009, aboard an Atlas V launch vehicle. LRO's suite of instruments is on track to make the observations needed to provide valuable information about potential exploration sites on the Moon. The latest updates on LRO are available at www.nasa.gov/mission_pages/LRO/main/index.html. LCROSS impacted the lunar surface to investigate the presence or absence of water in the Cabeus crater near the southern lunar pole of the Moon on October 9, 2009. The data from the impact is being analyzed.

FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
Launch the Lunar Reconnaissance Orbiter. (LRO)	6ESS1 Green	7ESRT4 Green	8AC14 Yellow	9AC12 Green
Launch the Lunar Crater Observation and Sensing Satellite. (LCROSS)	None	None	8AC15 Yellow	9AC13 Green

Outcome 6.2: By 2012, develop and test technologies for in situ resource utilization, power generation, and autonomous systems that reduce consumables launched from Earth and moderate mission risk.

NASA demonstrated a prototype Lunar Electric Rover (LER) in two field tests in FY 2009. The LER will enable a crew of two astronauts to explore the Moon up to 100 kilometers away from the lunar outpost on short trips lasting up to 14 days. Two spacesuits are attached to the rear of the vehicle through an interface called a suitport. The suitports allow astronauts to enter the spacesuits through a rear hatch, and to quickly detach from the rover to perform extravehicular activities (EVA). Currently, astronauts on the ISS spend over an hour preparing for each EVA. The suitports will increase the efficiency of EVA operations by allowing astronauts to exit the rover within 10 to 15 minutes. NASA demonstrated simulated lunar surface EVA operations during the field tests using the LER and the suitports. When compared with similar operations using an unpressurized rover while wearing spacesuits, NASA found that astronaut fatigue was greatly reduced using the pressurized LER. NASA also increased the productivity of EVAs with the pressurized rover because the crew could travel a longer distance and perform more tasks in a day.

FY06	FY07	FY08	FY 2009
Green	Green	Green	Green

FY 2009 Annual Performance Goal	FY06	FY07	FY08	FY 2009
Demonstrate in field tests a proof-of-concept pressurized rover with EVA suitports that could enable surface exploration beyond the vicinity of the lunar outpost and improve EVA work efficiency.	None	None	None	9AC14 Green

Outcome 6.3: By 2013, sufficiently develop and test technologies for nuclear power systems to enable an informed selection of systems for flight development to provide power to a lunar outpost.

NASA successfully tested a lightweight composite radiator panel in a vacuum chamber that replicates the hard vacuum and extreme cold temperatures of space, with temperatures as low as minus 257 degrees Fahrenheit. The radiator, approximately six feet by nine feet, represents one of 20 panels that would be needed to cool the notional Fission Surface Power System. By performing this test, the team showed the radiator panel could reject the required heat at the proper temperature under realistic lunar conditions.

FY06	FY07	FY08	FY 2009
None	None	Green	Green

FY 2009 Annual Performance Goal	FY06	FY07	FY08	FY 2009
Demonstrate full-scale radiator panels in the laboratory at temperatures and heat transfer rates relevant to the reference 40-kilowatt fission surface power system for the lunar outpost.	None	7ESRT5 Green	8AC17 Green	9AC15 Green

Outcome 6.4: Implement the space communications and navigation architecture responsive to science and exploration mission requirements.

An uninterrupted, reliable network is essential to receive and transmit the data that makes NASA missions safe, efficient, and worthwhile. In FY 2009, NASA's Space Communications and Navigation (SCaN) program continued its development of a unified space communication and navigation network capable of meeting both robotic and human exploration needs. In April 2009, SCaN completed and base-lined the Executive Summary volume of the Architecture Definition Document. NASA refined the SCaN Architecture Definition Document to include an integrated network architecture, and space communications standards were developed for use in the next generation architecture. SCaN made advancements in Optical Communications Technology with a goal of demonstrating its utility to NASA missions prior to implementation decision. SCaN continued to develop software defined radio technology that will provide the necessary flexibility and scalability necessary in future space communications architecture. SCaN released the Space Network Ground Segment Sustainment (SGSS) Request for Proposal. This procurement will provide major modernization upgrades to the Space Network Ground Segment as well as the architectural basis for further integration of the SCaN networks towards a single, integrated network.

FY06	FY07	FY08	FY 2009
Green	Green	Green	Green

FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
Complete TDRS Replenishment Preliminary Design Review (PDR).	None	None	None	9SFS6 Green
Re-compete the Space Network, Near Earth Network and NISN operations and maintenance contracts to provide uninterrupted support of those networks.	None	None	None	9SFS7 Yellow
Complete a consolidated network modernization plan for all SCaN networks to meet existing and future science and exploration mission requirements.	None	None	8SFS02 Green	9SFS8 Green
			8SFS03 White	

Why NASA did not achieve APG 9SFS7: NASA did select a contractor for the operations and maintenance contract. However, two protests were filed against NASA's decision, which delayed the contract award. NASA extended the current contract to avoid an interruption in support.

Plan for achieving APG9SFS7: The protests are currently under review. SCaN has plans in place to implement this goal once the protests are adjudicated and an award can be made. Network Services continue uninterrupted, but the long-term impact is under assessment due to personnel attrition created by contract uncertainty.

Outcome 6.5: No later than 2020, demonstrate the capability to conduct an extended human expedition to the lunar surface and lay the foundation for extending human presence across the solar system.

LRO successfully completed its commissioning phase in September 2009 and moved into its operational phase. LRO began collecting science data from its entire suite of instruments during the commissioning phase. While the prime science activity of LCROSS is the impact into the Cabeus crater near the southern lunar pole of the Moon, scheduled for October 9, 2009, LCROSS also collected science data with a successful lunar fly-by on June 22, 2009. The LRO and LCROSS mission will provide the data necessary to design and plan future human missions to the Moon.

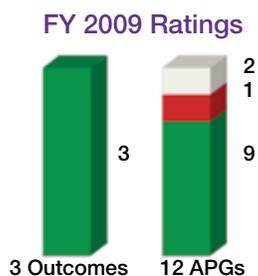
FY06	FY07	FY08	FY 2009
None	None	Green	Green

FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
Begin successful science data collection from the Lunar Reconnaissance Orbiter (LRO) in support of human lunar missions.	None	None	None	9AC16 Green
Begin successful science data collection from the Lunar Crater Observation and Sensing Satellite (LCROSS) in support of human lunar missions.	None	None	None	9AC17 Green
Conduct the Lunar Capabilities SRR to define the lunar mission architecture transportation requirements.	None	None	8CS12 Green	9CS11 Red

Why NASA did not achieve APG 9CS11: NASA did not hold the Lunar Capabilities System Requirements Review (SRR) in FY 2009. NASA established these performance measures while the project was in early formulation.

Plan for achieving APG9CS11: NASA has scheduled the Lunar SRR for early 2010. NASA replanned the project to reconcile with the availability of funds, and to identify an achievable schedule, with its FY 2010 budget request. However, NASA will re-examine this new project plan after the Review of U.S. Human Spaceflight Plans Committee (also known as the Augustine Committee) releases its final report.

Cross-Agency Support Programs Education



experiences to participate in the excitement of NASA's discoveries. NASA invests in teacher professional development, post-secondary STEM degrees, school-based resources, and multiple on-line learning options. NASA resources and opportunities are available to a diverse audience of educators and students, including women, minorities, and persons with disabilities.

Benefits

NASA's landmark achievements in air and space, made possible by scientific excellence and technical innovation, have deepened humankind's understanding of the universe while yielding down-to-Earth advances in air travel, health care, electronics, computing, and more. These achievements ultimately share a single source—education. NASA's Office of Education uses NASA's unique missions and vast scientific and technical experience to inspire and motivate America's future leaders.

To achieve NASA's Strategic Goals, the Agency must ensure a pipeline of highly skilled, diverse individuals. In the near-term, NASA will meet workforce needs by additional training for current employees and recruiting employees with skills and capabilities in emerging research and technology fields into the Agency. To meet long-term workforce needs, NASA's Education programs support internships and fellowships at NASA Centers, help inspire students at all levels to pursue STEM-related careers, provide professional development opportunities to STEM teachers, and develop interesting STEM content for the classroom, the Web, and informal learning environments like museums and community-based organizations.

Risks to Achieving Education's Outcomes

There are two risks to achieving NASA's education goals and objectives: securing a well-qualified future STEM workforce; and reversing the United States' declining global leadership in research and innovation. NASA's Office of Education is mitigating these risks by providing education opportunities that will engage students in STEM disciplines and attract them to relevant careers. The Office of Education coordinates with the Office of Human Capital Management to ensure that NASA's

NASA's Office of Education performs a leading role in inspiring the next generation of explorers through lessons, materials, research opportunities and hands-on activities that draw on NASA's unique missions. The National Research Council in 2008 stated that "NASA has a unique and important role to play in motivating and inspiring students to consider science, technology, engineering, and mathematics (STEM) careers, and citizens to become more knowledgeable participants in the scientific arena." Accordingly, NASA's ambitious STEM initiatives lead the Nation's exploration of Earth and its climate, the Moon, Mars, and beyond, as well as engage teachers and learners of all ages in various classrooms venues. The Office of Education works to align the NASA education strategy with national STEM priorities in collaboration with other Federal agencies, and state and local education leaders.

NASA is a leader among Federal Research and Development agencies in promoting STEM education opportunities. NASA partners with academic institutions, professional education associations, industry, and other government agencies to spark student interest and involvement by granting teachers and faculty unique



Credit: NASA

Disney's space ranger Buzz Lightyear returned from space on September 11, 2009, aboard Space Shuttle *Discovery's* STS-128 mission after 15 months aboard the International Space Station (ISS). While on the ISS, Buzz supported NASA's education outreach program by participating in a series of fun educational online outreach programs. Disney also is partnering with NASA to create a new on-line educational game and an on-line mission patch competition for school-aged children across America. NASA will fly the winning patch in space. In addition, NASA plans to announce on October 2 the details of a new educational competition that will give students the opportunity to design an experiment for the astronauts on the ISS.

portfolio of education investments align with the long-term human capital needs of the Agency. NASA also funds research for students, faculty, and supported institutions to foster innovation and STEM research for a new generation of scientists and engineers. By providing hands-on opportunities to students of all ages, engaging them in simulations and authentic research, NASA can stimulate creativity and help eliminate student fears of “difficult” STEM coursework.

FY 2010 Performance Forecast

In FY 2010, NASA’s Office of Education proposes to:

- Support more than 3,000 of the Nation’s talented undergraduate and graduate students studying in STEM fields with scholarships, internships, and fellowships;
- Recruit students who receive scholarships, internships, and fellowships from NASA into co-op and Federal Career Intern Program (FCIP) positions that are open at NASA Centers;
- Engage the capacity of over 550 of the Nation’s colleges and universities through the National Space Grant College and Fellowship Program to engage students in student launch activities, scholarships, research, and courses based upon NASA science and engineering;
- Provide over \$24 million in grants to universities to support NASA-related research and to enhance their capacity to compete for new Federal research dollars;
- Provide 470,000 K-12 students with hands-on STEM experiences based on NASA’s science and engineering disciplines;
- Link students in every state to NASA’s missions—including the flight of Educator Astronaut Dorothy Metcalf-Lindenburger—via the Internet, Digital Learning Network, and other interactive technologies;
- Provide stipends, scholarships, internships, and fellowships for 350 underserved and underrepresented individuals beginning their careers as new faculty or entering the K-12 teaching profession;
- Ensure every Minority Serving Institution in the Nation has an awareness of NASA education and the tools necessary to support students applying for NASA support;
- Release three student design competitions, providing middle- and high-school students an opportunity to participate in activities based upon NASA’s work, based on science and Shuttle missions launched in 2010;
- Publish interim results of the 2008 and 2009 NASA K-12 Competitive Grant Program, including linkages between authentic research and field-based studies for students, new science courses for secondary school or dual credits (high school and college) based on NASA content, and new technology tools that extend the reach and impact of NASA activities to diverse audiences;
- Streamline applications for undergraduate and graduate students seeking internships and fellowships at NASA Centers, thus allowing students to apply to multiple centers and internship programs through one application; and
- Connect prospective students to current interns via social networking technologies to allow peer-to-peer mentoring and coaching.

Outcome ED.1: Contribute to the development of the Science, Technology, Engineering and Math (STEM) workforce in disciplines needed to achieve NASA’s strategic goals through a portfolio of investments.

The Office of Education provides opportunities to help students and educators gain hands-on experience in a range of STEM-related areas, through NASA internships, fellowships, and research experiences. The goal is to give students the motivation, inspiration, and experience they need to serve the Nation’s current and future workforce needs. Education continued to exceed several of its annual performance goals, including a goal of developing 60 new STEM-related educational courses. The Office of Education exceeded this goal by developing 236 new courses in FY 2009. NASA also served 209 institutions in 26

FY06	FY07	FY08	FY 2009
Green	Green	Green	Green

Experimental Program to Stimulate Competitive Research (EPSCoR) participating states during the fiscal year, well above the target of serving 132 institutions.

NASA Education continued to track trends for higher education students participating in its programs. Based on the most recent data gathered, 41 percent of students who participated in NASA undergraduate programs went on to pursue advanced degrees. NASA exceeded its fiscal year target for increasing the number of students from NASA's higher education programs that entered into NASA-related careers. Out of 811 students who self-reported employment data, 466 students (or 57 percent) reported working for NASA, aerospace contractors, and universities and other educational institutions. An additional 12.7 percent (103 of the 811) went into other STEM career fields.

FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
Support the development of 60 new or revised courses targeted at the STEM skills needed by NASA.	None	None	8ED01 Green	9ED1 Green
Serve 200 institutions in designated EPSCoR states.	None	None	8ED02 Green	9ED2 Green
Engage 8,500 underrepresented and underserved students in NASA higher education programs.	6ED6 Green	7ED02 Green	8ED03 Green	9ED3 Red
Increase the percentage of higher education program participants who have participated in NASA elementary or secondary programs by an additional ten percent above the FY 2007 baseline of eighteen percent.	6ED4 Yellow	7ED4 Green	None	9ED4 White
	6ED5 Green	7ED5 Green		
Achieve fifty-five percent of student participants in FY 2009 NASA higher education programs, will be employed by NASA, aerospace contractors, universities, and other educational institutions.	None	None	None	9ED5 Green
Achieve forty percent of undergraduate students in FY 2009 NASA higher education programs, move on to advanced education in NASA-related disciplines.	None	None	None	9ED6 Green

Why NASA did not achieve APG 9ED3: In FY 2008, 6,776 higher education students self-reported being part of an underserved and underrepresented audience (based on race or ethnicity). This represents 28 percent of the number of higher education students served by NASA in FY 2008. Of all higher education students, 41 percent self-reported being women. (Note: data reported is from FY 2008 due to the grant reporting cycle.)

The reduction in direct student support reflects an increased Congressional emphasis on research, achieved through institutional (not individual student) awards. The overall reduction in direct support to higher education students affects the total number of higher education underserved and underrepresented students reached by the Office of Education. In FY 2007, the total number of higher education students reached was 34,493; in FY 2008, it dropped to 24,362.

Higher education projects have shifted operations to address this new direction, but there is significant lag time before results are available (e.g., new course development time, time to execute activities, grant reporting lag time). Additionally, budgets for higher education projects are effectively flat-lined, but per participant costs for grants are increasing. To offer competitive awards to individuals, NASA grantees (e.g., Space Grant) must increase award sizes that meet cost increases in tuition, travel, and other expenses. In a flat budget environment, an increase in award size means that fewer direct support awards can be made.

Plans for achieving APG 9ED3: All higher education projects are actively working to increase engagement of underrepresented and underserved students. For example, Space Grant program management is successfully encouraging state consortia to increase efforts to engage underrepresented students and to better include more minority-serving institutions in their organizations. In FY 2007, 15 percent of all students reached by Space Grant self-reported being of an underrepresented race or ethnicity. This percentage rose to 21 percent in FY 2008. Future efforts include work with community colleges, an environment with large numbers of underserved audiences.

Why NASA rated APG 9ED4 White: The APG was closed out, with concurrence from the Office of Management and Budget.

Outcome ED-2: Attract and retain students in STEM disciplines through a progression of educational opportunities for students, teachers and faculty.

NASA's Office of Education continues to attract and retain students in STEM disciplines through educational opportunities for students, teachers, and faculty. Examples of success in attracting and retaining students in STEM disciplines in FY 2009 include:

FY06	FY07	FY08	FY 2009
None	None	Green	Green

- Over 700 thousand students designed greenhouse chambers to study plants grown from seeds that flew in space, for NASA's Lunar Plant Growth Chamber Engineering Challenge. Students also conducted classroom experiments that may help NASA find new ways to grow and sustain plants in space and on the Moon;
- 1,318 high school interns were engaged in NASA STEM activities in NASA's Interdisciplinary National Science Program Incorporating Research and Education Experience (INSPIRE) Program, which has been implemented across NASA's 10 Centers, and is focused on targeting and attracting underrepresented and underserved students;
- The new Digital Learning Network (DLN) technology enabled NASA scientists and engineers to virtually "beam" into classrooms throughout the Nation. These electronic interactions reached over 135 thousand students in FY 2009; and
- The NASA Explorer Schools project reached over 85,000 students through instructional and enrichment activities.

FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
Increase the percentage of elementary and secondary educators, who receive NASA content-based STEM resources materials or participate in short-duration activities that use these materials in the classroom by four percent above the FY 2007 baseline of fifty-five percent.	None	7ED6 Green	8ED05 Green	9ED7 Green
		7ED7 Green		
		7ED8 Green		
Increase the number of elementary and secondary student participants in NASA instructional and enrichment activities by 10 percent above the FY 2007 baseline of 408,774.	None	7ED6 Green	8ED04 Green	9ED8 Green
		7ED7 Green		
		7ED8 Green		
Assure seventy-two percent of elementary and secondary educators who participate in NASA training programs use NASA resources in their classroom instruction, an increase in the FY 2007 baseline of sixty-two percent.	None	None	None	9ED9 Green
Achieve fifty percent or greater level of interest in science and technology careers among elementary and secondary students participating in NASA education programs.	6ED4 Yellow	7ED4 Green	None	9ED10 Green
	6ED5 Green	7ED5 Green		

Outcome ED-3: Build strategic partnerships and linkages between STEM formal and informal education providers that promote STEM literacy and awareness of NASA's mission.

NASA promoted a continuous awareness of its Mission and STEM literacy by partnering with the NASA Museum Alliance, the Space Place Network (in every state), the Smithsonian, NASA Visitor Centers, and the Office of Education on a number of special projects. In FY 2009, 400 museums and science centers used NASA resources in programs and exhibits. NASA selected some of these institutions to develop and implement public engagement activities and enhance education programs related to space exploration, aeronautics, space science, Earth science, or microgravity through the Science Museums and Planetarium Grants initiative.

FY06	FY07	FY08	FY 2009
None	Green	Green	Green

FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
Assure that at least 350 museums and science centers across the country actively engage the public through NASA content.	None	None	8ED06 Green	9ED11 Green
Assure that twenty percent of the 460 museums and science centers that participate in NASA networks use NASA resources in programs and exhibits.	None	None	8ED06 Green	9ED12 White

Why NASA rated APG 9ED12 White: This measure was eliminated with management concurrence, as it was determined to be duplicative of measure 9ED11.

Cross-Agency Support Programs

Agency Management and Operations (AMO)

- A corporate approach to managing unique or highly specialized facilities to sustain Agency-wide critical capabilities; and
- Support for technology development and transfer.

This Theme is divided into five programs: Agency Management, Safety and Mission Success, Agency Information Technology Services, Innovative Partnerships Program, and Strategic Capabilities Assets Program.

AMO

Agency IT Services (AITS)

NASA's Agency Management and Operations (AMO) Theme covers a wide range of functional and administrative management services across the Agency, including procurement, finance, human capital, real property and infrastructure, security, diversity, equal opportunity, and small business.

AMO programs provide:

- Policy and oversight to assure compliance with external and internal requirements;
- Support services to assure safety and mission success;

The AITS Program provides business and management applications, common IT infrastructure, IT security, and IT management services necessary for Agency operations in accordance with the Office of Management and Budget guidance, Federal laws and regulations, and industry best practices. The AITS Program includes Applications, IT Infrastructure (which includes IT security), and IT Management.

NASA established the Integrated Enterprise Management Program (IEMP) in 2000 to modernize and integrate NASA's business systems and processes. Since then, IEMP implemented 15 Agency-wide business systems in support of the Agency's Strategic Plan. IEMP provided quality information to decision makers prior to completing the program in FY 2009.

NASA established the Advanced Business Systems (ABS) Theme in FY 2006 to reflect the implementation of Agency-wide business systems as a direct program. At the beginning of FY 2009, IEMP was transferred from the ABS Theme to the Agency Information Technology Services (AITS) within the Agency Management and Operations Theme, where it is managed within the Office of the Chief Information Officer.



Benefits

IEMP has helped transform the Agency's business systems, processes, and procedures to improve financial management and accountability and to increase efficiency and cost savings across the Agency. The program implemented new systems and processes that:

- Provide employees and management with new, secure tools for accessing personnel data and planning and budgeting NASA's workforce;
- Allow better safety and management of flight operations and logistics for the Agency's aircraft fleet; and
- Standardize travel planning, travel expense reimbursement, travel payment processing, travel credit card reconciliation, and travel management reporting for NASA.

Risks to Achieving IEMP Outcomes and Other Support Activities

One of NASA's continuing business risks is a lack of resources to implement new systems or enhancements to existing systems to eliminate identified gaps. The Management/Business Systems Integration Group continues to identify gaps in Agency-wide business systems and processes. Funds will be needed to continue to modernize and improve the Agency's business systems so that the progress achieved to date through IEMP and other programs is not lost. IEMP funds available to support new development efforts are no longer available and business systems improvements and upgrades will need to be prioritized against other Agency investment requirements.

The Agency also needs to ensure that effective governance mechanisms are in place to prioritize the gaps so that the Agency's most important needs are addressed with the resources available. As part of this process, potential impacts on Center and key mission support organizations must also be considered.

FY 2010 Performance Forecast

The NASA Enterprise Applications Competency Center (NEACC) is assigned to the Agency Office of the Chief Information Officer (OCIO) at NASA Headquarters. NEACC will continue to focus on providing cost-effective systems management and operations and on improving service to customers across NASA. NEACC will begin implementing solutions to resolve the business systems gaps discussed above. During 2010, the Real Property Management (RPM) project will be in the Implementation Phase of an Agency-wide RPM solution. The RPM will support the Agency, the Office of Infrastructure, and the Office of Chief Financial Officer by providing the capability to improve NASA's internal controls over property, plant, and equipment. The RPM project will deliver the integration and functional capabilities needed to produce timely, reliable financial and real property information. These capabilities will help to effectively manage program and mission assets by leveraging Real Property Management capabilities within the Agency's Enterprise Resource Planning System.

Outcome IEM-1: By 2012, implement Agency business systems that provide timely, consistent and reliable business information for management decisions.

NASA completed the eTravel project, an Agency-wide implementation of an on-line travel solution with a single service provider, FedTravel. The Human Capital Information Environment (HCIE) project completed implementation of reports that were identified as necessary to meet project success criteria. The NASA Aircraft Management Module completed Phase 2 implementation in August 2009. During 2009, NEACC continued to enhance the operational Integrated Enterprise Management solutions during monthly, mid-year and year-end releases.

FY06	FY07	FY08	FY 2009
None	Green	Green	Green

FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
Implement all reports into the Human Capital Information Environment and stabilize the project and environment.	None	None	8IEM02 Green	9IEM1 Green
Implement the federal eTravel initiative to provide a standardized, comprehensive tool to support online booking, travel planning, travel expense reimbursement, payment processing, credit card reconciliation, and management reporting for NASA.	None	None	None	9IEM2 Green

Outcome IEM-2: Increase efficiency by implementing new business systems and reengineering Agency business processes.

The final implementation FedTravel provides NASA travelers with a comprehensive, online travel planning tool. HCIE project implemented critical reports and integrations with other Human Capital systems. The Aircraft Management Information System completed its final phase, providing Agency-wide processes, data, and reporting of aircraft, flight, and flight crew information. IEMP reduced the baseline for the funds distribution process from 65 days to between six and 12 days, depending on the number of projects within that Mission Directorate. Additionally, IEMP reduced the baseline for financial statements quarterly

FY06	FY07	FY08	FY 2009
Green	Green	Green	Green

corrective adjustments from eight to seven percent. The NASA Property, Plant and Equipment (PP&E) System provided the Agency with a cost savings of \$14.7 million, resulting from the integration of financial and asset management systems, a reduction in the number of redundant properties, and better management of PP&E assets.

FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
Reduce the number of quarterly corrective adjustments to financial statements from the 2006 baseline of 5948 steps to the 2009 goal of 2509 steps (a 58 percent reduction).	None	None	None	9IEM3 Green
Improve the timeliness of the funds distribution process (time from receipt of apportionment to distribution of funds to Centers) from 65 days to the 2009 goal of 12 days.	None	None	None	9IEM4 Green
Achieve cost savings, expected to increase annually with a 2009 goal of \$19.3 million, resulting from the integration of financial and asset management systems, a reduction in the number of redundant property, plant and equipment (PP&E) systems and process improvements that enable NASA to better manage PP&E assets.	None	None	None	9IEM5 Red

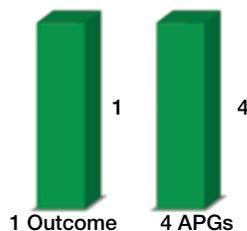
Why NASA did not achieve 9IEM5: NASA implemented the PP&E System in May 2008 resulting in a cost savings during FY 2009 of \$14.7 million, which is 76 percent of the goal as currently stated. However, further evaluation early in the Implementation Phase while providing a business case update resulted in the cost savings for the project being reduced. The initial benefit cost savings for reutilization of assets and loss reduction was overstated substantially based on the recent year's data. However, the NASA FY 2009 Performance Plan measure had already been submitted prior to this revision in cost savings.

Plans for achieving 9IEM5: The APG was unrealistic and will not be achieved as currently stated.

AMO

Innovative Partnerships Program (IPP)

FY 2009 Ratings



To achieve NASA's mission in an affordable and sustainable manner, the Agency partners with industry and academia to leverage outside investments and expertise while providing an economic incentive to invest in NASA programs. Advancing technology through partnerships has always been important to NASA, not only to address NASA's needs, but also to apply NASA-derived technology to a range of applications that provide broad benefit to the public.

IPP supports multiple Strategic Goals and Sub-goals in NASA's Strategic Plan and serves all four Mission Directorates with offices across NASA's ten Centers. Mission Directorates outline their technology needs, and IPP helps satisfy those needs through research and development with efficient strategic partnerships. IPP consists of three elements: Technology Infusion, Innovation Incubator, and Partnership Development. Together, these program elements serve to increase the range of technology solutions for NASA, enable cost avoidance, and accelerate technology maturation.

Benefits

IPP provides the technology solutions for NASA programs and projects through dual-use technology development and joint-partnerships. By broadening NASA's connection to emerging technologies, IPP provides an increased range of technological solutions for programs while reducing costs.

IPP provides technology transfer out of NASA (called spinoffs) for commercial or socio-economic benefit to the Nation. In addition, IPP facilitates protection of the government's rights in NASA's inventions, as mandated by legislation. Technology Transfer, Small Business Innovative Research (SBIR), and Centennial Challenges tap into sources of innovation outside NASA and leverage NASA's resources with private or other external resources to develop new technologies for NASA mission use. IPP also transfers technologies having strong potential for commercial applications yielding public benefits. All of IPP's functions primarily serve NASA's mission interests, both near- and long-term, and with respect to a broad range of technologies and technology readiness. IPP targets a broad spectrum of U.S. industrial and non-profit entities and provides them the opportunity for grass-roots direct involvement in NASA's exploration and other missions.

Risks to Achieving IPP Outcomes and Other Support Activities

Due to a constrained budget environment, IPP will reduce Technology Transfer Partnerships by more than one-third across all Centers, make fewer SBIR and Small Business Technology Transfer (STTR) awards, and reduce the Center support-contractor workforce. In addition, IPP will not fund any new Centennial Challenges. To meet this budgetary challenge, IPP is focused on continuing program management efficiencies. In its 2008 Program Assessment Rating Tool (PART) review, IPP received high ratings for overall program management. As part of the PART improvement plan, IPP will conduct regular independent evaluations of the program's effectiveness and establish and maintain a system for collecting program performance data in a way that meets verification and validation standards.

FY 2010 Performance Forecast

- IPP will develop at least 12 technology-related significant partnerships, and complete at least 30 technology transfer agreements with the commercial and academic community through licensing, software use agreements, facility use agreements, and Space Act Agreements.
- IPP will continue ongoing prize competitions, awarding one or more prizes to further encourage partnerships with innovative technology providers, including the emerging commercial space sector.

Outcome IPP-1: Promote and develop innovative technology partnerships among NASA, U.S. industry, and other sectors for the benefit of Agency programs and projects.

IPP adds value to NASA programs and projects by developing technologies and infusing those advanced technologies into NASA programs and projects, to meet mission needs. IPP leverages limited NASA funding to address NASA's technology gaps through cost-shared, joint-development partnerships with industry, academia, other government agencies, and National Laboratories. IPP helps to secure NASA's intellectual property rights to technologies developed for the Agency. IPP transfers NASA inventions and technologies out of the Agency for commercial application and other public benefit. The program engages Mission Directorates at both Headquarters and Center Levels and reaches out to external sectors, to increase participation from new sources in addressing NASA's technology challenges.

FY06	FY07	FY08	FY 2009
Green	Green	Green	Green

In FY 2009, IPP facilitated over 30 partnership agreements with the private sector, government agencies, academic institutions, and other non-profit entities for technology development facility usage, testing at NASA facilities, and software usage. In addition, IPP created nine, one-year joint technology development projects to advance new bio-analysis techniques and cryogenic fluids management on the International Space Station (ISS). In a joint initiative with the Office of Chief Engineer, IPP selected 20 projects, involving nine Centers, to support NASA inventors in the early stages of formulating concepts for development of novel technologies and processes. These novel technologies and processes have the potential to revolutionize the way NASA performs its missions, or enable new capabilities in space flight, science, aeronautics, and exploration. Through technology development NASA has the potential to address National and global challenges.

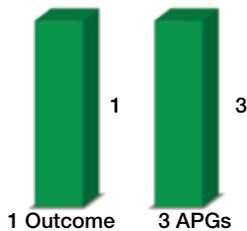
FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
Develop twelve technology-related significant partnerships that create value for NASA's programs and projects. Track both quantitative dollar value and qualitative benefits to NASA (e.g. reduced volume or mass, improved safety).	None	7IPP1 Green	8IPP01 Green	9IPP1 Green
Complete thirty technology transfer agreements with the commercial and academic community through such mechanisms as licenses, software use agreements, facility use agreements, and Space Act Agreements.	None	7IPP2 Green	8IPP02 Green	9IPP2 Green
Fully implement a new system for managing NASA's technology transfer and partnership information, that is more user friendly and less costly than the current NASA Technology Transfer System (NTTS).	None	7IPP3 Green	8IPP03 Green	9IPP3 Green
Infuse technologies from the IPP portfolio into NASA's programs and projects, with at least twelve documented infusion successes.	None	None	None	9IPP4 Green

AMO

Strategic Capabilities Assets Program (SCAP)

NASA established SCAP to ensure key capabilities and assets, such as wind tunnels and test facilities at Centers, are available for future missions and to help NASA prioritize and make strategic investment decisions to replace, modify, or disposition these capabilities/assets. SCAP is managed at the Agency level, with funding and day-to-day management responsibilities, generally residing in Centers and in the Office of Infrastructure and Administration. Mission Directorates share management responsibilities with SCAP on the Aeronautics Test Program and High-End Computing Columbia Program.

FY 2009 Ratings



Benefits

SCAP serves each NASA Mission Directorate by providing the facilities and capabilities to investigate, test, and establish new scientific and engineering theories, principles, and methods. SCAP establishes alliances between the NASA Centers with like assets, makes decisions on disposition of capabilities no longer required, identifies re-investments and re-capitalization opportunities within and among classes of assets, executes changes, and reviews

these capabilities each year to ensure the requirements are still valid. SCAP ensures that NASA has the assets and capabilities needed to achieve the Agency's Mission by strategically managing capabilities, setting uniform use policies, and reducing budget constraints, by eliminating redundant and unneeded assets.

Other government agencies, industry, and academia use the SCAP facilities to enhance their resources in meeting project requirements. The resulting advanced technologies often have dual-use capabilities that improve the Nation's position in the global marketplace, and its defense capabilities.

Risks to Achieving SCAP's Outcome and Other Support Activities

Given that only selected, limited, investments are available for the recapitalization of test facilities managed by SCAP, there is a possibility that test facilities will not meet requirements at the desired test date.

FY 2010 Performance Forecast

- SCAP will concentrate on sustaining the infrastructure (i.e., the basic facilities, skilled workforce equipment, services, and components required to sustain or enhance the facility itself) within asset classes and between Centers. SCAP also will institute consistency in reimbursable pricing policies, conduct quarterly program reviews for better management insight into the capabilities, and provide a forum for cooperation among all the Centers within asset classes.
- SCAP in FY 2009 will initiate outreach and in-reach activities to provide user awareness of the assets and the unique set of capabilities within the SCAP portfolio and to encourage greater use of these facilities.
- SCAP is committed to developing and implementing disposition plans for assets within its purview, when no longer required by the Agency.

Outcome SC-1: Establish and maintain selected Agency level shared capabilities, across multiple classes of assets (e.g., wind tunnels, vacuum chambers, etc.), to ensure that they will continue to be available to support the missions that require them.

SCAP continues to establish and maintain critical Agency-level shared capabilities to ensure their continued availability. In FY 2009, SCAP completed critical maintenance and re-capitalization on the unique set of SCAP assets.

FY06	FY07	FY08	FY 2009
None	Green	Green	Green

Over the last two years, SCAP:

- Procured a Liquid Nitrogen shroud for the Marshall Space Flight Center Thermal Vacuum Chamber to provide the capability to cool the test environment rapidly, thereby decreasing the total test time. This SCAP facility enhancement supports both human spaceflight and robotic space programs.
- Refurbished a 1946 Steam Turbine Feedwater pump for the Ames Arc Jet that supplies the main boiler. This is an important project since the Ames Arc Jet is used for the majority of NASA's Thermal Protection System and is used to simulate the heat generated during Earth re-entry.
- Replaced the antiquated video system and Barco projectors in the Ames Research Center Vertical Motion Simulator. This SCAP project enhanced the cockpit simulator for use as a research platform for NASA's work on advanced cockpit situation displays. The goal is to develop a low-cost, but highly realistic, cockpit environment, with controls that closely match those in the actual aircraft, while providing the flexibility to easily adapt to different spacecraft or aircraft pilot displays.

SCAP evaluates and validates the need for retention of all of NASA's assets annually and reallocates funds accordingly. For example, NASA closed the Coating Chamber at Marshall Space Flight Center in FY 2008, which enabled SCAP to reallocate FY 2009 funding to the VF5 and VF6 Thermal Vacuum Chambers at Glenn Research Center. The reallocated funds allowed the Thermal Vacuum Chambers to attract new customers this year. NASA will continue to renew and modernize its facilities to sustain its capabilities to meet current and future mission requirements, and NASA will accommodate those capabilities in fewer, more efficient facilities.

SCAP also identified and prioritized additional deferred maintenance, re-investment, and re-capitalization opportunities, which were validated by an independent study completed in 2009 by Jacobs Engineering. The technical capabilities and expertise available from the SCAP assets will provide for mission success and lower costs to the projects by reducing risk during testing.

FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
Prioritize funding requirements and select classes of assets for inclusion in the Shared Capability Assets Program.	None	7SC1 Green	8SC01 Green	9SC1 Green
Identify re-investment/re-capitalization opportunities within and among classes of assets and execute the approved changes (e.g., reallocate funds, upgrade facilities, etc.).	None	7SC2 Green	8SC02 Green	9SC2 Green
Assets identified in FY 2008 that no longer have requirements for use by NASA will be dispositioned (decision made on whether to place on standby, be mothballed, be demolished, etc.).	None	None	8SC03 Green	9SC3 Green

NASA's Uniform and Efficiency Measures

NASA uses Uniform and Efficiency Measure APGs to track performance in a number of program and project management areas, including life cycle schedule and cost and competitive award processes. NASA organizes the Efficiency Measure APGs by Theme to emphasize and encourage individual program accountability.

34 APGs			
Green	Yellow	Red	White
23	3	5	3

FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
Science Mission Directorate				
Earth Science				
Complete all development projects within 110% of the cost and schedule baseline.	6ESS24 Red	7ESS21 Yellow	8ES15 Yellow	9ES21 Red
<p>Description of Goal: This APG, which contributes to the accomplishment of Sub-Goal 3A, focuses on keeping NASA's portfolio of Earth Science projects within their baselines as they move from the start of building through testing to launch. NASA allows up to a 10 percent slip for a Green rating to allow for the unavoidable difficulties associated with one-of-a-kind development activities and for problems beyond the project manager's control, such as launch delays caused by a crowded launch manifest. For large-scale (life cycle over \$250 million) projects that exceed their development cost by 15 percent or more or their key milestone date by six months or more, NASA sends an analysis of the project plan and potential alternatives to Congress.</p> <p>Why NASA did not achieve APG 9ES21: NASA did not complete the Glory mission and the Orbiting Carbon Observatory (OCO) within 10 percent of their cost and schedule baselines. The Glory mission has experienced significant cost and schedule growth due to the failure of the OCO Taurus XL launch vehicle and issues in the vendor's production of acceptable boards for the Maxwell Single Board Computers (SBC). Glory's current projected lifecycle cost is 68 percent higher than the baseline established at the Confirmation Review. The project is currently working toward a November 2010 launch readiness date, a 64 percent increase in schedule.</p> <p>The OCO mission, which was lost in February 2009 due to a launch vehicle failure, slightly exceeded the thresholds, experiencing a 12 percent schedule delay and a 14 percent cost increase.</p> <p>Plans for achieving 9ES21: The Glory mission is currently scheduled for launch in November 2010.</p>				
Deliver at least 90% of scheduled operating hours for all operations and research facilities.	6ESS25 Green	7ESS22 Green	8ES16 Yellow	9ES22 Green
<p>Description of Goal: Operating spacecraft must deliver a high percentage of their scheduled operating hours for NASA to achieve the Outcomes under Sub-Goal 3A and to keep data flowing to researchers and decision-makers across the United States and the world.</p>				
Peer-review and competitively award at least 90%, by budget, of research projects.	6ESS26 Green	7ESS23 Green	8ES17 Green	9ES23 Green
<p>Description of Goal: Through open solicitation, NASA engages the Earth science community to identify research priorities for the community and the Nation. NASA's Earth Science Division issues research announcements, based on the identified priorities, for which members of the community can propose projects. The peer-review process ensures that the proposals selected are scientifically sound and technologically feasible. In an environment of limited funds, peer-review helps NASA apply funds to the highest priority areas.</p>				
Reduce time within which 80% of NRA research grants are awarded, from proposal due date to selection, by 5% per year, with a goal of 130 days.	None	7ESS24 Red	8ES18 Green	6ES24 Red
<p>Description of Goal: Timely awards of research grants keep NASA on track to respond quickly to the science community and to meet its research outcomes under Sub-Goal 3A. Timely awards also help make the best use of appropriated research funds during the fiscal year.</p> <p>Why NASA did not achieve APG 9ES24: The time-span in which 80 percent of Earth Science selection notifications were made increased during FY 2009. A small number of programs with long notification times, about 35 percent of proposers affected resulted in the lack of improvement in Earth Science notifications. The bulk of notifications are being made more quickly; the median notification time has shown average sustained improvement of six percent per year since FY 2005. In FY 2009, staff turnover, and the need to clear the books of overdue selection notifications from FY 2008, also impacted Earth Science.</p> <p>Plans for achieving 9ES24: Changes being made to reduce delayed selection notifications include scheduling proposal due dates to spread out the work for the understaffed research program managers and providing tentative notifications to proposers when budget uncertainty (e.g., lack of appropriations, lack of operating plan) delays final decision authority.</p>				

FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
Heliophysics				
Complete all development projects within 110% of the cost and schedule baseline.	6ESS24 Red	7ESS21 Yellow	8HE07 Red	9HE10 Yellow
<p>Description of Goal: This APG, which contributes to the accomplishment of Sub-Goal 3B, focuses on keeping NASA's portfolio of Heliophysics projects within their baselines as they move from the start of building through testing to launch. NASA allows up to a 10 percent slip for a Green rating to allow for the unavoidable difficulties associated with one-of-a-kind development activities and for problems beyond the project manager's control, such as launch delays caused by a crowded launch manifest. For large-scale (life cycle over \$250 million) projects that exceed their development cost by 15 percent or more or their key milestone date by six months or more, NASA sends an analysis of the project plan and potential alternatives to Congress.</p> <p>Why NASA did not achieve APG 9HE10: NASA did not complete the Solar Dynamics Observatory (SDO) within 110 percent of cost and schedule baselines. SDO initially slipped from its 2008 firm slot in the launch manifest due to late delivery of avionics boxes and instruments, and problems with electronics parts and the high-speed data bus. SDO has since experienced difficulty obtaining a new slot in the launch manifest, as no firm slots were available until 2010 due to multiple Atlas V launch vehicle issues and associated launch queue delays.</p> <p>Plans for achieving 9HE10: SDO is currently scheduled to launch in February 2010. This exceeds the original schedule by 48 percent, but the mission is still expected to be completed within 10 percent of the original cost baseline.</p>				
Deliver at least 90% of scheduled operating hours for all operations and research facilities.	6ESS25 Green	7ESS22 Green	8HE08 Green	9HE11 Green
<p>Description of Goal: Operating spacecraft must deliver a high percentage of their scheduled operating hours for NASA to achieve the Outcomes under Sub-Goal 3B and to keep data flowing to researchers and decision-makers across the United States and the world.</p>				
Peer-review and competitively award at least 95%, by budget, of research projects.	6ESS25 Green	7ESS22 Green	8HE09 Green	9HE12 Green
<p>Description of Goal: Through open solicitation, NASA engages the solar and space physics community to identify research priorities for the community and the Nation. NASA's Heliophysics Division issues research announcements, based on the identified priorities, for which members of the community can propose projects. The peer-review process ensures that the proposals selected are scientifically sound and technologically feasible. In an environment of limited funds, peer-review helps NASA apply funds to the highest priority research areas.</p>				
Reduce time within which 80% of NRA research grants are awarded, from proposal due date to selection, by 5% per year, with a goal of 130 days.	6ESS27 Green	7ESS24 Red	8HE10 Yellow	9HE13 Green
<p>Description of Goal: Timely awards of research grants keep NASA on track to respond quickly to the science community and to meet its research outcomes under Sub-Goal 3B. Timely awards also help make the best use of appropriated research funds during the fiscal year.</p>				
Planetary Science				
Complete all development projects within 110% of the cost and schedule baseline.	6SSE29 Red	7SSE10 Red	8PS09 White	9PS11 Red
<p>Description of Goal: This APG, which contributes to the accomplishment of Sub-Goal 3C, focuses on keeping NASA's portfolio of Planetary Science projects within their baselines as they move from the start of building through testing to launch. NASA allows up to a 10 percent slip for a Green rating to allow for the unavoidable difficulties associated with one-of-a-kind development activities and for problems beyond the project manager's control, such as launch delays caused by a crowded launch manifest. For large-scale (life cycle over \$250 million) projects that exceed their development cost by 15 percent or more or their key milestone date by six months or more, NASA sends an analysis of the project plan and potential alternatives to Congress.</p> <p>Why NASA did not achieve APG PS11: NASA did not complete the Mars Science Laboratory (MSL) within 10 percent of its cost and schedule baselines. Development problems with critical electronic and mechanical devices resulted in delaying MSL's launch to the next Mars launch window in October-December 2011. This represents a 70 percent schedule increase, with an associated cost increase of approximately 46 percent.</p> <p>Plans for achieving PS11: MSL is currently scheduled to launch in November 2011.</p>				
Deliver at least 90% of scheduled operating hours for all operations and research facilities.	6SSE30 Green	7SSE11 Green	8PS10 Green	9PS12 Green
<p>Description of Goal: Operating spacecraft must deliver a high percentage of their scheduled operating hours for NASA to achieve the Outcomes under Sub-Goal 3C and to keep data flowing to researchers and decision-makers across the United States and the world.</p>				

FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
<p>Peer-review and competitively award at least 95%, by budget, of research projects.</p> <p>Description of Goal: Through open solicitation, NASA engages the solar and space physics community to identify research priorities for the community and the Nation. NASA's Planetary Science Division issues research announcements, based on the identified priorities, for which members of the community can propose projects. The peer-review process ensures that the proposals selected are scientifically sound and technologically feasible. In an environment of limited funds, peer-review helps NASA apply funds to the highest priority research areas.</p>	6SSE31 Green	7SSE12 Green	8PS11 Green	9PS13 Green
<p>Reduce time within which 80% of NRA research grants are awarded, from proposal due date to selection, by 5% per year, with a goal of 130 days.</p> <p>Description of Goal: Timely awards of research grants keep NASA on track to respond quickly to the science community and to meet its research outcomes under Sub-Goal 3C. Timely awards also help make the best use of appropriated research funds during the fiscal year.</p>	6SSE32 Green	7ESS13 Red	8PS12 Green	9PS14 Green
Astrophysics				
<p>Complete all development projects within 110% of the cost and schedule baseline.</p> <p>Description of Goal: This APG, which contributes to the accomplishment of Sub-Goal 3D, focuses on keeping NASA's portfolio of Astrophysics projects within their baselines as they move from the start of building through testing to launch. NASA allows up to a 10 percent slip for a Green rating to allow for the unavoidable difficulties associated with one-of-a-kind development activities and for problems beyond the project manager's control, such as launch delays caused by a crowded launch manifest. For large-scale (life cycle over \$250 million) projects that exceed their development cost by 15 percent or more or their key milestone date by six months or more, NASA sends an analysis of the project plan and potential alternatives to Congress.</p> <p>Why NASA did not achieve APG 9AS12: NASA did not complete the Kepler mission within 10 percent of its cost and schedule baselines. The Kepler prime contractor and many of its sub-contractors were not able to execute planned activities within the cost and schedule they had proposed. One of the major challenges was the focal plane array integration. The focal plane on Kepler, with 42 large CCDs, is the largest ever flown in space and has stringent requirements on science performance. Although management changes were made and other actions taken to address issues, the schedule for the focal plane array took longer, and hence cost more, than originally planned. Launch manifest conflicts also contributed to the 24 percent schedule delay and 18 percent cost increase.</p> <p>Plans for achieving 9AS12: NASA launched the Kepler mission on March 6, 2009.</p>	6UNIV22 White	7UNIV9 Red	8AS09 Yellow	9AS12 Yellow
<p>Deliver at least 90% of scheduled operating hours for all operations and research facilities.</p> <p>Description of Goal: Operating spacecraft must deliver a high percentage of their scheduled operating hours for NASA to achieve the Outcomes under Sub-Goal 3D and to keep data flowing to researchers and decision-makers across the United States and the world.</p>	6UNIV23 Green	7UNIV10 Green	8AS10 Green	9AS13 Green
<p>Peer-review and competitively award at least 95%, by budget, of research projects.</p> <p>Description of Goal: Through open solicitation, NASA engages the solar and space physics community to identify research priorities for the community and the Nation. NASA's Astrophysics Division issues research announcements, based on the identified priorities, for which members of the community can propose projects. The peer-review process ensures that the proposals selected are scientifically sound and technologically feasible. In an environment of limited funds, peer-review helps NASA apply funds to the highest priority research areas.</p>	6UNIV24 Green	7UNIV11 Green	8AS11 Green	9AS14 Green
<p>Reduce time within which 80% of NRA research grants are awarded, from proposal due date to selection, by 5% per year, with a goal of 130 days.</p> <p>Description of Goal: Timely awards of research grants keep NASA on track to respond quickly to the science community and to meet its research outcomes under Sub-Goal 3D. Timely awards also help make the best use of appropriated research funds during the fiscal year.</p>	6UNIV25 Yellow	7UNIV12 Green	8AS12 Yellow	9AS15 Green
Aeronautics Research Mission Directorate				
Aeronautics Technology				
<p>Deliver at least 94% of "on-time availability" for all operations and research facilities.</p> <p>Description of Goal: NASA has one of the largest, most versatile, and comprehensive set of aeronautics research facilities in the United States. Four NASA Centers—Ames Research Center, Dryden Flight Research Center, Langley Research Center, and Glenn Research Center—operate facilities for subsonic, transonic, supersonic, and hypersonic research, as well as design and modeling for fundamental aeronautics, aeronautics safety, and next-generation airspace systems, used by NASA's Aeronautics Technology programs, other government agencies, and industry. Keeping the facilities operating within required specifications and on time is critical to maintaining excellence in U.S. aeronautics and airspace systems research.</p>	6AT12 Green	7AT8 Yellow	8AT17 Yellow	9AT12 Green

FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
Exploration Systems Mission Directorate				
Constellation				
Complete all development projects within 110% of the cost and schedule baseline.	6CS5 Green	7CS9 White	8CS14 White	9CS14 White
<p>Description of Goal: This APG, which contributes to the accomplishment of Strategic Goal 4, focuses on keeping individual projects contributing to NASA's new space transportation systems within their baselines as they move from the start of building through testing to full operational capability. In FY 2007 and FY 2008, none of the projects had entered development, earning a White rating. For large-scale (life cycle over \$250 million) projects that exceed their development cost by 15 percent or more or their key milestone date by six months or more, NASA sends an analysis of the project plan and potential alternatives to Congress.</p> <p>The other APGs that Constellation Systems reviewed to determine the rating for this Uniform Measure are 9CS1, 9CS2, 9CS3, 9CS4, 9CS5, 9CS6, 9CS7, 9CS11, and 9CS12. (APG 9CS14 was published in the FY09 Performance Plan as 9CS12.)</p> <p>Why NASA rated APG 9CS14 White: This APG is not valid until a the project enters the development phase (after KDP-C). A triple KDP-C event is scheduled for Orion, Ares I, and Ground Operations in summer 2010.</p>				
Reduction in ground operations cost (through 2012) of the Constellation Systems based on comparison with the Space Shuttle Program.	None	None	8CS15 Green	9CS13 White
<p>Description of Goal: NASA is transitioning facilities and equipment, including ground operations, from the out-going Space Shuttle Program to the new Constellation Systems Program. As part of this, NASA is working to make the ground operations that will serve Constellation Systems more efficient and cost effective, helping to make Constellation Systems a better value to the Nation than the Space Shuttle Program.</p> <p>Why NASA rated APG 9CS13 White: Constellation, in consultation with their OMB analyst, determined that this APG was not measureable and canceled it for FY 2009. They have rewritten the measure for FY 2010. The first measure point will be the program Critical Design Review scheduled for fall 2012.</p>				
Advanced Capabilities				
Complete all development projects within 110% of the cost and schedule baseline.	6ESRT13 White	7ESRT6 White	8AC18 Yellow	9AC18 Yellow
<p>Description of Goal: This APG, which contributes to the accomplishment of Strategic Goal 6, focuses on keeping individual projects contributing to NASA's lunar return program within their baselines as they move from the start of building through testing to operations. For large-scale (life cycle over \$250 million) projects that exceed their development cost by 15 percent or more or their key milestone date by six months or more, NASA sends an analysis of the project plan and potential alternatives to Congress.</p> <p>The other APGs that Advanced Capabilities reviewed to determine the rating for this Uniform Measure are 9AC12, 9AC13, 9AC14, and 9AC15.</p> <p>Why NASA did not achieve APG 9AC18: While the LRO, LCROSS and the VCAM projects were within their cost baselines, they did not comply with the 110 percent schedule baseline. For LRO and LCROSS, there were technical problems with the launch vehicle systems which contributed to the launch delays. For VCAM, there were technical problems encountered in the development of the instrument which resulted in the schedule delay.</p> <p>Plans for achieving 9AC18: LRO and LCROSS were launched on June 18, 2009, and the VCAM successfully completed its pre-ship review on August 26, 2009.</p>				
Increase the amount of research beam time for space radiation experiments at NSRL, hence science data collection, by reducing the non-science overhead to 25% from 33% for set up, tuning, and maintenance.	None	None	None	9AC19 Green
<p>Description of Goal: Radiation exposure is the biggest risk to humans exploring space. The NASA Space Radiation Laboratory beam line simulates the cosmic rays found in space so that researchers can study the effects of radiation on human health, and to find effective ways to mitigate or prevent the damaging effects of space radiation. NASA seeks to increase the amount of time researchers have to conduct their experiments by reducing the time needed to keep the beam operational.</p>				

FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
<p>Given an annual constant dollar technology funding, demonstrate improvements in the EVA Work Efficiency Index for humans and robots working cooperatively to deploy the power system infrastructure for the lunar outpost. Work Efficiency Index = (Time to complete a task using humans and robots) / (Time to complete a task using humans only).</p> <p><i>Description of Goal:</i> Work conducted during EVA is often complicated and exhausting, and astronauts spend many hours training for each EVA task. As part of the lunar return program, NASA is creating robotic assistants to reduce the number of EVA work hours placed on crew while still achieving mission goals. As robotic assistants become more efficient and capable, they will work alongside astronauts or autonomously to deploy infrastructure for a lunar outpost.</p>	None	None	None	9AC20 Green
Space Operations Mission Directorate				
International Space Station				
<p>Achieve an Annual Cost Performance Index (CPI), the ratio of the value of the work accomplished versus the actual cost of the work accomplished, of greater than or equal to one.</p> <p><i>Description of Goal:</i> CPI is the ratio of the value of the work accomplished versus the actual cost of the work accomplished. A ratio of 1 indicates the cumulative value of work accomplished within the fiscal year matches the cost accrued in the performance of the work during the same period. The current ISS plan assumes a reduction in the operational costs of ISS through its life after assembly is complete. Since the value of the work accomplished is tied to these planning assumptions, a CPI close to 1 is desirable because it shows efficiency in performance versus planning, yielding more value for taxpayer investment.</p> <p>Why NASA rated APG 9ISS7 White: This goal was discontinued because the ISS has transitioned from the development stage to the operations stage. During the development stage, CPI was a valid A because hardware was being delivered and contractors were being paid per delivery. During the operations stage, contractors are being paid to perform a function that is not tied to deliveries.</p>	None	None	8ISS08 Green	9ISS7 White
<p>Deliver at least 90% of scheduled operating hours for all operations and research facilities.</p> <p><i>Description of Goal:</i> Leading up to and beyond ISS assembly completion in 2010, the facilities provided throughout the life of ISS will be key to conducting research. This measure addresses those capabilities and resources needed to expand and validate future space flight applications and conduct research onboard the ISS: 20 research rack sites in the U.S. segment; the power to run the research racks; life-support systems capable of supporting a six-person crew; and the crew themselves to maintain and operate the facilities. These targets require comprehensive coordination with the International Partners, the Space Shuttle Program, U.S. national laboratory users, and commercial transportation providers.</p>	6ISS7 Green	7ISS7 Green	8ISS07 Green	9ISS8 Green
Space and Flight Support				
<p>Achieve at least 99% Space Network proficiency for delivery of Space Communications services.</p> <p><i>Description of Goal:</i> This measure tracks the percentage of minutes provided by the Space Network against the total number of minutes of communications uplink and downlink required by the International Space Station, the Space Shuttle, and low Earth-orbiting missions. These services are critical to the safety of crews aboard the ISS and Shuttle, the efficient navigation and operation of crewed and robotic spacecraft, and data return.</p>	None	None	8SFS04 Green	9SFS10 Green
<p>Complete all development projects within 110% of the cost and schedule baseline.</p> <p><i>Description of Goal:</i> NASA, in partnership with the Department of Defense, will be flying two new Tracking and Data Relay Satellites, TDRS-K and -L, to provide reliable space communications. This Uniform Measure was rated White in FY 2006, FY 2007, and FY 2008 while this project was in formulation. NASA's portion of the project is being conducted via a firm, fixed-price contract that will keep the project within its cost baseline. It is important for the project to remain within its schedule baseline to support future exploration plans. The other APG that Space and Flight Support reviewed to determine the rating for this Uniform Measure is 9SFS6.</p>	6SFS7 White	7SFS5 White	8SFS06 White	9SFS11 Green
<p>Ratio of Launch Services program cost per mission to average spacecraft cost, reduced to 6.3 percent.</p> <p><i>Description of Goal:</i> The cost of launching vehicles into space is very high, negatively impacting the cost of all flight missions. NASA is seeking to reduce the cost of launch for NASA and other government agency customers by reducing the cost of the Launch Services Program, which acquires launch vehicles, coordinates the launch manifest for NASA's launch pads, oversees launch operations, and manages the countdown. This metric will demonstrate cost effectiveness in achieving the program goal of launch success for NASA missions by calculating the approximate cost of program services and capabilities per mission.</p>	None	None	None	9SFS12 Green

FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
Space Shuttle				
<p>Annually reduce the Space Shuttle sustaining engineering workforce for flight hardware and software, while maintaining safe flight.</p> <p><i>Description of Goal:</i> The sustaining engineering workforce supports the program's ability to respond to and handle anomalies in a timely manner. NASA is focusing on transitioning completely this highly skilled workforce to Constellation System as the Shuttle nears retirement.</p>	None	None	8SSP5 Green	9SSP5 Green
<p>Deliver at least 90% of scheduled operating hours for all operations and research facilities.</p> <p><i>Description of Goal:</i> Operating hours for the Shuttle are defined as time when the Shuttle reaches orbit through to preparation for landing. To complete the remaining tasks, including ISS construction, on the Shuttle schedule before retirement, the Shuttle must operate at maximum capacity.</p>	6SSP3 Green	7SSP5 Green	8SSP06 Green	9SSP6 Green
Education				
<p>Reduce the dollar invested per number of people reached via e-education technologies from FY 2008 amounts.</p> <p><i>Description of Goal:</i> NASA will continue to use Internet- and Web-based technology to deliver content to reach ever-larger numbers of participants. The number of people reached is estimated based on the number of page views.</p>	None	None	None	9ED13 Green
<p>Reduce the cost per K-12 program participant over FY 2007 amounts by 1%.</p> <p><i>Description of Goal:</i> The Education Program will draw from audiences that have demonstrated interest in NASA and connect participants to the next level of engagement. A blend of projects and activities encourage continued student affiliation with NASA throughout their academic career, resulting in efficiencies in recruitment and retention. To continue serving the same number of participants, it will be necessary to reduce the cost per participant.</p> <p>Why NASA did not achieve APG 9ED14: Research in science, technology, engineering, and mathematics (STEM) education shows that projects and activities that provide hands-on experiences, intensive internships, and sustained educator professional development relationships are more effective in positively affecting STEM teaching and learning. NASA's Office of Education (OE) has strategically adjusted its elementary and secondary portfolio to include greater investments in these types of experiences, which are more costly, but more effective than short-term, broad-based activities like one-time workshops, auditorium-style presentations and school visits, etc. Elementary and secondary education programming is changing direction within a flat-line (or decreasing core program budget) and this goal is no longer feasible.</p> <p>Plans for achieving APG 9ED14: OE is pursuing increased investment in activities with higher per participant costs. A balanced OE education portfolio still includes projects and activities with lower costs per participant and reaches large numbers of students and educators. Averaging these different types of investments in one efficiency measure is not practical. OE plans to work with their OMB analyst to revise the performance measure to more accurately reflect new OE strategies and Administration emphasis on high-impact (high cost per participant) investments.</p>	None	None	None	9ED14 Red
Agency Management and Operations				
<p>Complete all development projects within 110% of the cost and schedule baseline.</p> <p><i>Description of Goal:</i> NASA is implementing IT systems to handle consistently, efficiently, and effectively cross-Agency services such as payroll, travel, procurement, property management, finances, information technology, and human capital. The quick and successful completion of this large program is key to addressing NASA's outstanding material weaknesses and management challenges and is central to Agency management and operations.</p> <p>The other APGs that NASA reviewed to determine the rating for this Uniform Measure are 9IEM1 and 9IEM2.</p>	None	None	8IEM06 Green	9IEM8 Green

FY 2009 Annual Performance Goals	FY06	FY07	FY08	FY 2009
<p>Reduce the number of financial processing steps/time to perform year-end closing from the 2005 baseline of 120 steps to the 2008 goal of 20 steps (an 83% reduction).</p> <p><i>Description of Goal: During FY 2008, NASA transitioned Accounts Payable, Accounts Receivable, and Fund Balance With Treasury reconciliation to the NASA Shared Services Center as part of the effort to consolidate processes at each Center into a single system, improve consistency, reduce redundant processes, and gain efficiencies. The Office of the Chief Financial Officer (OCFO) expects a reduction in the amount of processing steps, and therefore time, to close the Agency's finances for the fiscal year. At the same time, the OCFO is improving the oversight processes of the Continuous Monitoring Program to ensure that errors and inconsistencies are identified and corrected in a timely manner. This effort is helping address the material weakness—Financial Systems, Analyses, and Oversight—identified by the independent auditors.</i></p> <p><i>The other APG that NASA reviewed to determine the rating for this Uniform Measure is 9IEM3.</i></p> <p><i>Why NASA did not achieve APG 9IEM9: The focus of the measure collection, as written, is on the number of processing steps required to support yearend close. The FY 2008 year-end closing required 98 steps and a system run time of 59 hours (three days). However, a more accurate measure of efficiency improvements achieved is the amount of time that the system is not available to the end users. The system unavailability was reduced from 60-system hours/four and one-half days. The reduction in time relates to system unavailability for processing and that is what is important to the end users.</i></p> <p><i>Although the number of steps was not reduced as planned with the upgrade to SAP version ECC 6.0, there was significant reduction in the amount of time that SAP was unavailable to end users during the close process. The upgrade to ECC 6.0 reduced runtime of closing programs from 60 hours to 51 hours, and allowed analyst to perform concurrent years processing, entering FY 2008 data within days of closing the last period in FY 2007.</i></p> <p><i>Plans for achieving 9IEM9: The reduction in number steps is not an accurate measure of efficiency achieved. The more important measure is the amount of system downtime reduced, which impacts the end users. Therefore, a more appropriate APG has been incorporated into the FY 2010 Performance Plan, to accurately measure the improvements. APG 10IT12 states, "In 2010, reduce the amount of system execution time during the year-end close process by six hours." Based on improved performance of additional hardware, preliminary FY 2009 system executive hours are on target for the six hour reduction noted in FY 2010 Performance Plan measure.</i></p>	None	None	8IEM07 Red	9IEM9 Red
<p>For technology partnerships, leverage IPP funding by bringing at least an additional \$1.80 (one dollar and eighty cents) for each \$1 (one dollar) of IPP funds.</p> <p><i>Description of Goal: The Innovative Partnerships Program cultivates cost-sharing partnerships to develop technologies that will meet Mission Directorate needs. In return, the partner can develop the technology for commercial use. Through this metric, IPP calculates the money it invests in partnerships versus the money invested by the partners. By leveraging the funding invested by the partners, IPP lowers the eventual cost of the resulting technology for NASA.</i></p> <p><i>The successful completion of this Efficiency Measure contributes to the successful completion of APG 9IPP1</i></p>	None	None	None	9IPP7 Green

NASA's Performance Improvement Plan Update for FY 2008

Description	Rating	Why the Measure Was Not Met	Plans for Achieving the Measure in FY 2008
Aeronautics Research Mission Directorate			
Aeronautics Technology			
8AT10 (Outcome 3E.3)			
Develop a rotorcraft model, validated with data from gear noise and vibration testing, to predict reductions in gear vibration transmission.	Red	The researcher at the Glenn Research Center responsible for technical activities related to this milestone retired at the end of 2007. The highly specialized skill required for modeling of gear noise and vibration was not readily available to conduct research in-house.	The Subsonic Rotary Wing project decided to conduct this research through a NASA Research Announcement (NRA). In 2008, NASA competitively selected two universities, Ohio State University and Penn State University, through the NRA process to conduct research on gear noise and vibration modeling. The milestone will be complete in 2010.
FY 2009 Update: The NASA-university teams, Ohio State University and Pennsylvania State University, have made good technical progress through FY 2009. The milestone will be complete in 2010.			
8AT11 (Outcome 3E.3)			
Demonstrate a composite supersonic engine fan blade containment system that is 20 percent lighter than the High Speed Research Program metallic containment system and validate through laboratory tests.	Yellow	The vendor responsible for the scaled structural sub-elements for the High Speed Research Program had planned to manufacture and test the elements by the third week of September 2008. A carbon fiber supply chain backlog and a widespread power outage in southwestern Ohio delayed the manufacturing of the elements.	NASA expects to receive the elements sometime in November 2008. Once NASA receives the elements, testing will be completed in a week. Assuming a positive outcome from the test, the milestone will be completed at the end of November 2008.
FY 2009 Update: The High Speed Research Program completed this milestone in December 2008. The completion date slipped due to contractor manufacturing delays. Flat plate and panel ballistic impact testing was completed for four advanced composite concepts (a thick laminate and three variations of an emerging sandwich composite technology), as well as a baseline fan case material used in the conventional hard-wall containment design approach. Based on the test results, prior research and development experience with advanced composite concepts for subsonic engine containment, and recent technology transition/ commercialization partnerships with engine industry, the program now estimates the weight reduction potential to be 25 to 50 percent, which exceeds the APG.			
8AT14 (Outcome 3E.3)			
Evaluate state-of-the-art hypersonic flight simulation tools, ablator systems, and GNC technologies using data from suborbital SOAREX flight 1.	Red	The Hypersonic Boundary Layer Transition (HyBoLT) and Sub-Orbital Aerodynamic Re-entry Experiments (SOAREX) were part of the payload on an experimental rocket, ALV-XI, developed by ATK. The rocket with its two payloads was launched from Wallops Flight facility on August 22 and was destroyed less than 30 seconds after liftoff when the rocket failed to align its trajectory on the correct flight path. The HyBoLT payload transmitted 20.5 seconds of data; however, the rocket did not reach Mach 2, which is the required speed for the experiment. It is not known whether the data will be useful but HyBoLT's sensors were working and recording data. HyBoLT would have transmitted approximately 75 seconds of data had the rocket not been destroyed. The SOAREX experiment was separated from the rocket during the incident and obtained ten seconds of data. The usefulness of these data is unknown. SOAREX was not designed to operate until HyBoLT had separated from the rocket.	Both HyBoLT and SOAREX tests were designed to obtain relevant data under hypersonic flight conditions, which cannot be obtained in ground tests. The Hypersonics project will pursue other flight test opportunities through partnerships with other government agencies and organizations. An example is partnership with the Air Force on the Hypersonic International Flight Research Experiments (HIFIRE) program, in which NASA is a partner for three of the HIFIRE flights. These flight experiments will provide critical boundary layer transition, mode transition, and aerothermal heating data under hypersonic flight conditions, which will be used to validate models developed by NASA.
FY 2009 Update: The Hypersonics project has leveraged additional flight opportunities within the Agency, as well as with external partners to utilize flight data to support the development of applicable technologies and tools. In particular, Aeronautics Research has collaborated with the Space Shuttle Program to analyze experimental data collected from a Shuttle re-entry experiment. The Hypersonics Project also will use data collected from flight 1 of the HiFire hypersonic flight experiment. While the intent of this milestone has been satisfied, NASA will continue to take advantage of other flight opportunities in the future.			

Description	Rating	Why the Measure Was Not Met	Plans for Achieving the Measure in FY 2008
8AT16 (Outcome 3E.4)			
Develop a long-term, flight operations/ test infrastructure vision and funded plan working with all the appropriate stakeholders, to assure that the plan reflects the priorities of the long-term needs of the Nation.	Yellow	NASA did not achieve APG 8AT16 due to program management changes in the second quarter of FY 2008. The incoming program manager made several visits to the Dryden Flight Research Center during the second and third quarter FY 2008 to understand the issues and opportunities for NASA flight testing and this new understanding resulted in a management decision to engage the RAND corporation for support in developing a new strategic plan.	ATP awarded a contract to the RAND corporation in the fourth quarter FY 2008 for this effort and the scheduled completion is during the second quarter FY 2009.
FY 2009 Update: ATP completed the development of a Strategic Plan during the last quarter of FY 2009. The implementation of this Strategic Plan for flight operations and test infrastructure will happen in FY 2010. ATP's funding profile has been developed to support this plan. Development of the plan took longer than expected due to the complexity and the coordination among relevant parties.			
8AT17 (Efficiency Measure)			
Deliver at least 90 percent of scheduled operating hours for all operations and research facilities.	Yellow	Several significant tests originally planned for ATP facilities in FY 2008 were either cancelled by the test customer or moved into another fiscal year. In addition, a number of unexpected breakdowns and construction project delays occurred at several facilities at Langley Research Center, resulting in the delivery of 71 percent of scheduled operating hours for ground test assets.	ATP will continue to work with Centers and portfolio managers to accurately estimate, project, and secure test activities for its test capability assets. In addition, ATP will continue to invest in test facility maintenance and upgrade projects with the goal of improving facility reliability, availability and overall attractiveness to test customers. However, due to the age and current condition of the facilities, system failures and the resulting unplanned downtime are constant risks. To mitigate this in FY 2009, ATP will develop a new program management strategy and will use this strategy to implement recommendations for its ground test facilities and related infrastructure from the comprehensive, independent facility condition assessment commissioned in FY 2008.
FY 2009 Update: ATP worked with the portfolio managers at the three aeronautics ground research Centers to more accurately and consistently estimate, project, and secure test activities for FY 2009. In addition, ATP continued to invest in test facility maintenance and upgrade projects with the goal of improving reliability, availability, and overall attractiveness to test customers. Due to the age and current condition of the facilities, however, system failures and the resulting unplanned downtime are constant risks, and, due to the evolution of program and project testing requirements, slipped and cancelled tests will continue to happen. Facility age and condition and program and project evolution are risk areas inherent to the research test facility business. Although not an APG in FY 2009, the delivery of scheduled operating hours (preliminary but based on actuals through the end of the third quarter) is projected to increase to about 80 percent from approximately 70 percent in FY 2008. For FY 2009, NASA has changed the Efficiency Measure to measure on-time availability, which more accurately addresses performance of the program.			

Description	Rating	Why the Measure Was Not Met	Plans for Achieving the Measure in FY 2008
Exploration Systems Mission Directorate			
Constellation			
Outcome 4.1			
No later than 2014, and as early as 2010, transport three crewmembers to the International Space Station and return them safely to Earth, demonstrating an operational capability to support human exploration missions.	Yellow	Prior milestones need to be completed before the Orion and EVA PDRs are held.	The SDRs and PNARs gave approval for the Ares 1, Orion, Ground Operations, and Mission Operations projects to proceed toward PDR. The EVA Systems project is underway to complete its PNAR in early FY 2009. As a result of several Government Accountability Office (GAO) bid protests concerning the award of the Constellation Space Suit System (CSSS) prime contract and the subsequent termination of that contract in FY 2008, NASA is in the process of taking corrective action with this procurement and will be updating its project milestones to accommodate the delay in the award of the CSSS contract, including rescheduling its PDR and subsequent internal technical reviews.
FY 2009 Update: NASA did not meet Outcome 4.1 this fiscal year. However, NASA reviewed resources for the Constellation Program in preparation for the FY 2011 presidential budget request and revised both program estimated life-cycle cost and schedule. As a result, NASA has revised the Outcome to reflect a new initial operating capability commitment date of 2015. The Constellation Program successfully completed KDP-1 in August 2009 and is on track to complete KDP-2 in summer 2010, which will allow the program to progress from the formulation phase into the implementation phase. Additionally, Ares I and Orion have already completed their Preliminary Design Reviews (PDRs); Ground Operations and Mission Operations are on track to complete their PDRs in FY 2010; and EVA's PDR is scheduled for FY 2011. NASA anticipates achieving this Outcome in FY 2010.			
8CS01 (Outcome 4.1)			
Complete the Preliminary Design Review (PDR) for the Orion/Crew Exploration Vehicle (CEV).	Yellow	NASA did not achieve the APG due to the refinement in the deliverable schedules since the time these metrics were established. These metrics were established when the project was still in early formulation.	Since establishment of these goals, NASA refined the Orion project schedule and shifted the PDR to align with the new program milestones. The Orion project continues to perform Design Analysis Cycles that will lead to the PDR currently scheduled for FY 2009.
FY 2009 Update: NASA met the revised plan for this Outcome. The Orion project successfully completed its PDR on August 31, 2009. The project will enter development in FY 2010 and has initiated design analysis cycles that will inform the Critical Design Review.			
8CS06 (Outcome 4.1)			
Complete the Preliminary Design Review (PDR) for the Extravehicular Activity (EVA) Systems.	Yellow	NASA established these metrics when the EVA Systems project was still in early formulation. Since then, the project found it necessary to refine its schedule during the reporting period by shifting the PDR to align with new program milestones. In addition, in response to several protests filed by the Exploration Systems and Technology LLC (EST)—the unsuccessful offeror—with the GAO between contract award on June 12 and September 29, 2008, NASA notified the GAO that it determined that "corrective action" was appropriate and, as part of the corrective action, NASA terminated the original Constellation Space Suit System (CSSS) contract awarded to Oceaneering International, Inc. (OI) for the convenience of the government. The GAO then dismissed the original EST protest and all supplemental protests as "academic," given NASA's decision to take corrective action.	NASA is implementing a corrective action plan and will update its key project milestones accordingly to accommodate that plan. NASA is replanning the EVA Systems project preliminary design efforts to accommodate the delay. Although the GAO protests have been dismissed, Federal acquisition regulations still prohibit NASA from discussing details about a pending procurement matter.
FY 2009 Update: NASA did not meet the FY 2008 APG. However, NASA reviewed resources for the Constellation Program in preparation for the FY 2011 presidential budget request and revised both program estimated life-cycle cost and schedule. As a result, NASA has revised the Outcome to reflect a new initial operating capability commitment date of 2015. The resulting replanned schedule moved the EVA PDR date to early 2011.			

Description	Rating	Why the Measure Was Not Met	Plans for Achieving the Measure in FY 2008
8CS08 (Outcome 5.2)			
Complete the Flight Demonstration 1 Readiness Review leading up to demonstration flights in FY 2009.	Yellow	In an effort to enable commercial success in this high-risk venture, NASA has negotiated the agreement timeline at the request of one of the COTS partners.	The flight Demonstration 1 Readiness Review is delayed until March 2009, and NASA expects that the long-term goals of the program will be met.
FY 2009 Update: NASA did not meet the plans for achieving the measure. The Flight Demonstration 1 Readiness Review is being aligned to meet NASA agreed to timeline at the request of a COTS partner. The timeline currently projects the Flight 1 Readiness Review in November 2009 that supports a Demonstration 1 Launch in January 2010.			
8CS11 (Outcome 6.4)			
Provide the Command, Control, Communication and Information (C3I) standards, validation processes and test systems designs, and demonstrate life cycle feasibility at the Ground Operations and Mission Operations Preliminary Design Reviews (PDRs).	Yellow	Mission Operations and Ground Operations C3I specification volumes are not needed until the lunar phase.	These C3I specification volumes will be developed in time to support the Lunar Systems Requirement Review.
FY 2009 Update: NASA did not meet the FY08 APG. However, NASA reviewed resources for the Constellation Program in preparation for the FY 2011 presidential budget request and revised both program estimated life-cycle cost and schedule. As a result, NASA has revised the APG to reflect a new initial operating capability commitment date of 2015. The resulting replanned schedule moved the Lunar Systems Requirement Review to FY 2011.			
Advanced Capabilities			
8AC04 (Outcome 3C.4)			
The RAD instrument is scheduled for delivery to NASA's Jet Propulsion Laboratory for final integration with the MSL rover in February 2010. The Instrument Delivery Review was completed in December 2008. The instrument is currently in storage at the Southwest Research Institute.	Yellow	The slight slip in schedule was due to the need to address technical issues with the power systems and some failing parts at a vendor. Both these issues have been addressed to NASA's satisfaction.	The RAD instrument is scheduled for delivery to NASA's Jet Propulsion Laboratory for final integration with the MSL rover on November 10, 2008. RAD will be temporarily integrated with MSL the week of September 2, 2008, to verify electrical interfaces, and then returned to Southwest Research Institute for environmental testing. NASA does not anticipate any impacts to the MSL schedule.
FY 2009 Update: The RAD instrument is scheduled for delivery to NASA's Jet Propulsion Laboratory for final integration with the MSL rover in February 2010. The Instrument Delivery Review was completed in December 2008. The instrument is currently in storage at the Southwest Research Institute.			
8AC05 (Outcome 3F.1)			
Complete development of a renal stone countermeasure and validate it for use.	Yellow	NASA completed the experiment and results are on the ISS Web site, but the study has not yet been submitted for journal publication. This is due to the need for a human system risk board to occur in order to assess operational utility. This risk board meets on a regular basis to discuss human research findings with medical operations.	Project scientists will submit the results for publication in peer reviewed journals and present at national meetings after the human system risk board's assessment in the first quarter of 2009.
FY 2009 Update: The project scientists completed the analysis and the results have been accepted for publication in the <i>Journal of Urology</i> (Issue 182) for its November 2009 issue.			
8AC08 (Outcome 3F.1)			
Determine the stability of a controlled set of food/nutritional items and common medications, representative of the types and classes typically provided on space missions, after six months exposure to the space flight environment.	Yellow	The fourth kit of food/nutritional items and common medications is still in orbit. The other three have landed and have been analyzed.	The fourth kit will land in the first quarter of FY 2009 and then will be analyzed to complete the requirements of this APG.
FY 2009 Update: The last Stability kit (4 of 4) will be returned on STS-126 in November 2008. The project is completing final samples analysis and assessment of data across all kits, and they will provide the final report in December 2009. A manuscript based on Stability nutrition data was submitted, reviewed, and accepted for publication in the <i>Journal of Food Science: Assessment of nutrient stability in foods from the space food system after long-duration spaceflight on the ISS.</i>			

Description	Rating	Why the Measure Was Not Met	Plans for Achieving the Measure in FY 2008
8AC09 (Outcome 3F.2)			
Deliver two prototype life support systems: the Carbon Dioxide and Moisture Removal Amine System (CAMRAS); and the Sorbent Based Air Revitalization (SBAR) System.	Yellow	The third CAMRAS unit has not yet been delivered due to issues that arose during fabrication.	The third CAMRAS unit is scheduled to be delivered in November 2008. The other two units have already been delivered.
FY 2009 Update: The third CAMRAS Unit was delivered to NASA JSC on November 10, 2008, completing the requirements of this APG. The hardware was then used in CAMRAS Phase 4A performance testing, for which a quick-look test report was released on June 22, 2009.			
8AC10 (Outcome 3F.3)			
Deliver the Vehicle Cabin Atmosphere Monitoring (VCAM) flight hardware in preparation for launch to ISS.	Yellow	There is a high degree of uncertainty in availability of upmass (weight and volume capacity) for a February 2009 launch and a high likelihood for upmass availability for a July 2009 launch.	NASA may move the Pre-Ship Review date from September 30, 2008, to no later than December 15, 2008, and the additional time prior to shipment will be used for further characterization of VCAM performance. This characterization will improve understanding and confidence of on-orbit behavior.
FY 2009 Update: VCAM had some small leaks which compromised its high vacuum system. It also had some acoustic issues. Both were addressed, but required additional time. Thus NASA moved the Pre-ship Review to August 25, 2009. The VCAM instrument has successfully passed the Pre-ship Review and is scheduled to fly in March 2010.			
Outcome 6.1			
By 2008, launch a Lunar Reconnaissance Orbiter (LRO) that will provide information about potential human exploration sites.	Yellow	NASA completed all reviews except the Mission Readiness Review pertinent to the launch of LRO and LCROSS. To accommodate a U.S. Air Force (USAF) request, the LRO/LCROSS launch window has been swapped with that of the USAF Orbital Test Vehicle.	The new launch date for LRO/LCROSS is scheduled for early 2009.
FY 2009 Update: Though LRO experienced additional delays in early 2009 caused by external influences to the launch manifest. NASA launched LRO on June 18, 2009, and the spacecraft is performing well.			
8AC14 (Outcome 6.1)			
Complete the Critical Design Review (CDR), Mission Readiness Review (MRR), and Pre-Environmental Review (PER) for the Lunar Reconnaissance Orbiter.	Yellow	LRO is now scheduled for launch in early 2009 due to the need to swap launch dates with a U.S. Air Force launch. The LRO MRR is tied to the revised launch window and, therefore, was not completed in FY 2008.	LRO is progressing well in testing and would have been ready for a late 2008 launch had the swap with the USAF launch not occurred. NASA will hold the MRR prior to launch. NASA has completed the CDR and the PER.
FY 2009 Update: LRO completed its MRR on April 28, 2009, in support of its successful launch on June 18, 2009.			
8AC15 (Outcome 6.1)			
Complete the Critical Design Review (CDR) and Mission Readiness Review (MRR) for the Lunar Crater Observation and Sensing Satellite.	Yellow	LRO is now scheduled for launch in early 2009 due to the need to swap launch dates with a U.S. Air Force launch. The LRO MRR is tied to the revised launch window and, therefore, was not completed in FY 2008.	LRO is progressing well in testing and would have been ready for a late 2008 launch had the swap with the USAF launch not occurred. NASA will hold the MRR prior to launch. NASA has completed the CDR and the PER.
FY 2009 Update: LCROSS held its MRR on May 4, 2009, completing it with a Delta-MRR on May 13, 2009, in support of its successful launch on June 18, 2009.			
8AC18 (Efficiency Measure)			
Complete all development projects within 110 percent of the cost and schedule baseline.	Yellow	Schedule delays were due to the availability of the launch window for LRO and LCROSS (delayed launch window due to a launch swap, to give the USAF priority), contamination issues with the VCAM instrument, and a change in the heat shield material by the MSL project, which impacted the Mars Science Laboratory Entry, Descent, and Landing Instrument project.	NASA adjusted the LRO and LCROSS schedules to meet the new launch window. Technical issues are being addressed.
FY 2009 Update: NASA launched LRO and LCROSS on June 18, 2009. All slips (beyond the original LRO slip from October 2008 to November 2008) were caused by external factors. The LCC for the LRO project line (including LCROSS) remained below the 110 percent threshold despite the externally applied delays. The VCAM slipped its Pre-ship Review per its original schedule by almost one year due to unanticipated technical issues associated with integrating a complex hardware.			

Description	Rating	Why the Measure Was Not Met	Plans for Achieving the Measure in FY 2008
8AC19 (Efficiency Measure)			
Increase the relative amount technology products transferred to Constellation Systems developers for mission application compared to the total budget.	Yellow	The pace of technology maturation has slowed to accommodate a constrained budget environment due to Congressional redirection.	The rate of technology transition is not expected to increase significantly in the next several years.
FY 2009 Update: In 2008, Exploration Technology Development Program (ETDP) transitioned two technologies to the Constellation Program: a carbon dioxide and moisture removal system and a prototype heat shield for the Orion crew exploration vehicle. ETDP delivered the ENose environmental monitoring instrument and the Combustion Integrated Rack to the ISS Program; those were launched in 2008. On average, about two technologies are planned for transition each year to the Constellation and ISS Programs. In 2009, ETDP transitioned two technologies to the Constellation Program: the Max Launch Abort System, and an integrated health monitoring system for the Ares I-X ground hydraulics system. The Fluids Integrated Rack also will be launched to the ISS.			
Science Mission Directorate			
Earth Science			
8ES04 (Outcome 3A.3)			
Complete Orbiting Carbon Observatory (OCO) Operational Readiness Review.	Yellow	The OCO mission Operational Readiness Review (ORR) was originally scheduled to occur in June 2008, two months before the planned August 2008 launch readiness date (LRD). Due to delays in the OCO instrument development—persistent schedule delays with the instrument manufacturer caused project management at the Jet Propulsion Laboratory to transfer a significant amount of instrument work in-house—the project was rebaselined in April 2007, extending the LRD by three months to December 2008. Consequently, the ORR slipped to September 2008. In May 2008, the launch of OCO was delayed by one month, due to launch site availability. This shifted the ORR date again, moving it to November 2008.	NASA completed the ORR in November 2008.
FY 2009 Update: After completing the ORR in November, NASA launched OCO in February. Unfortunately, due to a failure of the launch vehicle, OCO was destroyed.			
8ES06 (Outcome 3A.4)			
Complete Global Precipitation Measurement (GPM) Mission Spacecraft Preliminary Design Review (PDR).	Yellow	NASA has rescheduled the GPM spacecraft PDR for FY 2009 to accommodate a revised funding plan.	NASA will conduct the spacecraft PDR with the mission-level PDR, which is scheduled to occur in the first quarter of FY 2009. This change was made to accommodate a slower Goddard Space Flight Center in-house staffing ramp-up in FY 2009 without impacting the 2013 core spacecraft launch readiness date.
FY 2009 Update: NASA completed the GPM Spacecraft PDR on November 10-13, 2008. The project continues to experience delays, as described under Sub-goal 3A.			

Description	Rating	Why the Measure Was Not Met	Plans for Achieving the Measure in FY 2008
Outcome 3A.5			
Progress in understanding the role of oceans, atmosphere, and ice in the climate system and in improving predictive capability for its future evolution.	Yellow	Performance toward this Outcome continues to be a concern due to uncertainties in climate data continuity and delays and technical issues related to the NPP mission. In particular, the NPOESS-developed Visible/Infrared Imager/Radiometer Suite (VIIRS) instrument continues to present significant development challenges, and NASA already knows that its performance will not meet all NPP Level-1 requirements and, therefore, will impact key climate research measurements of ocean color and atmospheric aerosols. VIIRS performance issues have been causing cost and schedule overruns, which impact not only the timely implementation of the systematic Earth observation missions, but the overall success of the flight program.	In addition to previous contractor management changes approved by the Tri-Agency (NOAA, Department of Defense, NASA) Executive Committee and implemented by the Integrated Program Office (IPO) on NPOESS, NASA is supplying key quality assurance personnel to support IPO technical management personnel in accelerating the completion of the VIIRS instrument. NASA also is undertaking a comprehensive analysis of science community requirements unlikely to be met by VIIRS as an initial step in devising a mitigation strategy.
FY 2009 Update: NASA followed this plan, and this fiscal year the Outcome is back on track, receiving a Green rating.			
8ES06 (Outcome 3A.5)			
Complete the Glory mission Operational Readiness Review (ORR).	Yellow	Challenges on developing the Aerosol Polarimetry Sensor (APS) instrument delayed the ORR. NASA rebaselined the Glory project in April 2008 to accommodate the late completion of the APS instrument, establishing a June 2009 LRD.	The ORR is scheduled to occur in early 2009.
FY 2009 Update: The Glory ORR currently is scheduled for May 2010. NASA delayed the launch date due to issues with the Taurus XL launch vehicle and with the vendor's production of acceptable boards for the Single Board Computers (SBC), requiring the project to switch to an alternate design solution.			
8ES10 (Outcome 3A.5)			
Complete the Aquarius Instrument Pre-ship Review.	Yellow	The Aquarius Instrument Pre-Ship Review was originally scheduled to occur in May 2008. However, due to schedule slips by NASA's foreign partner CONAE (Comisión Nacional de Actividades Espaciales, the Argentinean space agency) on the spacecraft development, NASA rebaselined the project first in November 2006 and then again in November 2007. These rebaselines delayed the Pre-Ship Review and delayed the launch a total of 14 months.	The Aquarius Instrument Pre-Ship Review was originally scheduled to occur in May 2008. However, due to schedule slips by NASA's foreign partner CONAE (Comisión Nacional de Actividades Espaciales, the Argentinean space agency) on the spacecraft development, NASA rebaselined the project first in November 2006 and then again in November 2007. These rebaselines delayed the Pre-Ship Review and delayed the launch a total of 14 months.
FY 2009 Update: NASA completed the Aquarius Instrument Pre-Ship Review on May 20, 2009.			
8ES15 (Efficiency Measure)			
Complete all development projects within 110% of the cost and schedule baseline.	Yellow	While NASA's cost and schedule performance on OSTM was excellent (launch in June 2008 was on schedule and under budget), OCO is projected to exceed its budget by 16 percent due to delays in instrument development.	OCO is currently scheduled to launch in January 2009 (9.8 percent beyond the scheduled launch date), meeting the schedule portion of the APG. Launch will conclude the development phase for this mission.
FY 2009 Update: The OCO mission was lost in a launch failure on February 24, 2009, when the payload fairing of the Taurus launch vehicle failed to separate during ascent.			

Description	Rating	Why the Measure Was Not Met	Plans for Achieving the Measure in FY 2008
8ES16 (Efficiency Measure)			
Deliver at least 90% of scheduled operating hours for all operations and research facilities.	Yellow	The Aura High Resolution Dynamics Limb Sounder (HIRDLS) instrument malfunctioned on March 17, 2008, and has not provided useful data since. A solid-state recorder anomaly on December 6, 2007 affected all Aura instruments, but losses from this anomaly were minimal.	The Level One Requirements Assessment held on August 15th, 2008, rebaselined the Aura mission to three-sensor operation. This robust mission had already met its minimum success criteria and has multiple ways to achieve remaining science objectives. The project has obtained all HIRDLS data essential to mission success and will fully process and archive the valuable dataset, making it available to the general science community. Since August 15th, NASA has successfully delivered over 90 percent of scheduled operating hours.
FY 2009 Update: NASA and its partners have been working to make Aura data available as stated last year. This fiscal year, Earth Science has returned to being Green for this Efficiency Measure.			
Heliophysics			
8HE07 (Efficiency Measure)			
Complete all development projects within 110% of the cost and schedule baseline.	Red	While NASA's cost performance on IBEX was good (less than four percent growth), it was launched 14.8 percent beyond its scheduled launch date due to launch vehicle and technical delays. Of greater concern, however, is the delayed launch of SDO and the accompanying cost growth. SDO slipped from its August 2008 firm slot in the launch manifest to a wait-list slot of December 2008 due to late delivery of avionics boxes and instruments and problems with electronics parts and the high-speed data bus. Due to the high demand for Atlas V launches, no firm slots were available until January 2010. NASA anticipates that the launch date will be between 30 and 46 percent beyond the launch date established at the Confirmation Review.	SDO has requested a firm slot on the launch manifest in January 2010 while preserving the option for a launch in June 2009, in the event that the manifested payload in the June slot is not ready for launch. Launch will conclude the development phase for this mission.
FY 2009 Update: The SDO launch is currently scheduled for February 2010. Due to this additional delay, NASA rated this year's Efficiency Measure Yellow. See Sub-goal 3B for more information about SDO.			
8HE10 (Efficiency Measure)			
Reduce time within which 80% of NRA research grants are awarded, from proposal due date to selection, by 5% per year, with a goal of 130 days.	Yellow	Due to significant improvement demonstrated in the last two fiscal years, Heliophysics had an ambitious target to meet in FY 2008. While it failed to meet the target, the program's FY 2008 performance was in line with that of the other Science Mission Directorate programs, which is notable given that Heliophysics prepared multiple missions for launch during the year. This necessarily altered the priorities of staff members who were also responsible for grant selections.	The Science Mission Directorate is continuing its successful efforts to improve the proposal review process, but future gains in processing time will continue to be limited by a number of factors. The most significant of these is the impact of continuing resolution funding on Heliophysics's ability to make prompt selection decisions early in the fiscal year. The requirement to obligate two-year funds in the first fiscal year also limits the number of selections that can be scheduled late in the fiscal year. However, civil service and contractor staffing constraints are such that an effort to schedule most or all of the selections in the middle of the fiscal year cannot be accommodated.
FY 2009 Update: The Science Mission Directorate's efforts have been successful, and Heliophysics met its FY 2009 target, receiving a Green for this Efficiency Measure.			

Description	Rating	Why the Measure Was Not Met	Plans for Achieving the Measure in FY 2008
Astrophysics			
8AS09 (Efficiency Measure)			
Complete all development projects within 110% of the cost and schedule baseline.	Yellow	While NASA's cost performance on Fermi met the threshold (five percent growth), NASA launched Fermi 32 percent beyond its scheduled launch date due to slips in completing the Command and Data Handling subsystem, spacecraft testing schedule conflicts with Department of Defense projects, and spacecraft contractor performance issues.	NASA successfully launched Fermi on June 11, 2008, completing the development phase for this mission.
FY 2009 Update: The Fermi mission is operational and performing well. NASA rated this Efficiency Measure Yellow again this year due to the Kepler mission, which experienced both cost and schedule overruns (see Sub-goal 3D). NASA launched Kepler in March 2009, ending its development phase.			
8AS12 (Efficiency Measure)			
Reduce time within which 80% of NRA research grants are awarded, from proposal due date to selection, by 5% per year, with a goal of 130 days.	Yellow	Due to significant improvement demonstrated in the last two fiscal years (including a 15% decrease from FY 2006 to FY 2007), the Astrophysics Program had an ambitious target to meet in FY 2008. While it failed to meet the target, the program continues to demonstrate the best performance of the Science Mission Directorate programs.	The Science Mission Directorate is continuing its successful efforts to improve the proposal review process, but future gains in processing time will continue to be limited by a number of factors. The most significant of these is the impact of continuing resolution funding on the program's ability to make prompt selection decisions early in the fiscal year. The requirement to obligate two-year funds in the first fiscal year also limits the number of selections that can be scheduled late in the fiscal year. However, civil service and contractor staffing constraints are such that an effort to schedule most or all of the selections in the middle of the fiscal year cannot be accommodated.
FY 2009 Update: The Science Mission Directorate's efforts have been successful, and Astrophysics met its FY 2009 target, receiving a Green for this Efficiency Measure.			
Space Operations Mission Directorate			
Space Shuttle			
8SSP04 (Outcome 1.2)			
A nine percent reduction (over FY 2007 values) in the annual value of Shuttle production contracts for Orbiter, External Tank, Solid Rocket Boosters, Reusable Solid Rocket Motor, Space Shuttle Main Engine and Launch & Landing, while maintaining safe flight.	Yellow	Production and hardware recycling contracts for external tank, main engine, and ground operations processing workforce needed to be maintained longer than anticipated to support the five flights per year now planned for FY 2009 and FY 2010.	The Space Shuttle Program will continue to allocate resources in a manner that ensures the safe flyout of the manifest.
FY 2009 Update: Resources continue to be allocated in support of a safe flyout of the manifest. The Space Shuttle Program is anticipating a seven percent reduction (between FY 2007 and FY 2009) in the annual value of Shuttle production contracts, and a 39 percent reduction (between FY 2007 and FY 2010) in FY 2010.			
Cross-Agency Support Systems			
Advanced Business Systems (Agency IT Services)			
8IEM05 (Outcome IEM-2)			
Increase percentage of total travel booking completed on-line, from the 2006 baseline of 1.8 percent to the 2008 goal of 50 percent.	Yellow	The on-line booking tool, FedTraveler.com, has only been deployed to a pilot Center as of FY 2008. Agency-wide deployment and utilization of the on-line tool will not be achieved until FY 2009.	NASA is on track to achieve this goal. The pilot center deployment yielded a 76 percent online adoption rate. Similar results will be expected once the on-line booking tool, FedTraveler.com, is fully deployed to the Agency by FY 2009.
FY 2009 Update: In June 2008, NASA implemented a pilot implementation of the eTravel solution at Kennedy Space Center followed by a wave implementation of the remaining NASA Centers in March and April 2009. The Agency-wide on-line adoption rate is currently at 64 four percent, meeting the 2008 and 2009 APG.			

Description	Rating	Why the Measure Was Not Met	Plans for Achieving the Measure in FY 2008
8IEM07 (Efficiency Measure)			
<p>Reduce the number of financial processing steps/time to perform year-end closing from the 2005 baseline of 120 steps to the 2008 goal of 20 steps (an 83 percent reduction).</p>	<p>Red</p>	<p>The focus of the measure on "the number of steps or processes" is not the important factor; it is the measure of system unavailability "time" that is important. Time is mentioned in the measure description but is omitted from the metric collection. The reduction in time relates to the system "down time" or unavailability for processing during year-end processing; this is what is important to the end users as it impacts their ability to do their jobs. The baseline for the performance measure for "time" was four and a half days in FY 2006 and FY 2007 actual performance was three days.</p>	<p>Although IEMP reduced the number of steps from the baseline 120 to 103, in the future, the program will focus metric collection on the reduction in time.</p>
<p>FY 2009 Update: The reduction in the number of steps is not an accurate measure of efficiency achieved. The more important measure is the amount of system downtime reduced, which impacts the end users. Therefore, a more appropriate APG has been incorporated into the FY 2010 Performance Plan, to more accurately measure the improvements achieved. APG 10IT12 states, "In 2010, reduce the amount of system execution time during the year end close process by six hours." The FY 2008 year end closing required 98 steps and a system run time of 59 hours/three days. Efficiency was achieved in the reduction of the amount of time the system was unavailable to end users during the close process; the system unavailability was reduced from 60 system hours/four and one-half days. Based on improved performance of additional hardware, preliminary FY 2009 system executive hours are on target for the six hour reduction for the FY 2010 Performance Plan measure.</p>			



Financials



Message from the Office of the Chief Financial Officer

November 16, 2009



The National Aeronautics and Space Administration (NASA) takes seriously its responsibility for stewardship of the resources entrusted to it and for reporting on the Agency's performance and outcomes to the citizens of the United States, the President, and the Congress. Meeting these responsibilities has been a joint effort by the Agency's managers, employees and business partners. This Performance and Accountability Report details the results achieved through that joint effort.

To continue to meet the Agency's financial management responsibilities this year, NASA executed on its foundation for financial management excellence, which was established to improve operation of financial systems and processes and to drive financial performance across the Agency's operations and projects. As a result, NASA resolved a long-standing material weakness identified in the FY 2008 *Report on Internal Controls* related to financial systems, analyses, and oversight. Resolving this prior year weakness provides greater assurance to Agency decision-makers and to external stakeholders of the reliability of NASA's financial information. Also in FY 2009, through joint efforts by the Agency's managers, employees, and business partners, NASA implemented the American Recovery and Reinvestment Act of 2009 (ARRA), implemented the Federal Government's eTravel system, and continued to develop and deliver financial management education through the Office of the Chief Financial Officer's Professional Development initiative.

NASA's independent auditors reported a repeat material weakness related to the Agency's legacy Property, Plant, and Equipment (PP&E) in this year's *Report on Internal Controls*. Despite the improvements made in legacy PP&E accounting processes and systems, the auditors were unable to obtain sufficient evidential support for the amounts presented in the Agency's financial statements to enable them to express an opinion on those statements. The Agency is committed to resolving the legacy property weaknesses, particularly through the guidance contained in the recent release of Statement of Federal Financial Accounting Standard 35, *Estimating the Historical Cost of General Property, Plant, and Equipment*.

We look forward to sharing more of NASA's progress and successes in financial and resource management excellence.

A handwritten signature in black ink that reads "Terry Bowie". The signature is written in a cursive, flowing style.

Terry Bowie
Deputy Chief Financial Officer

Introduction to the Principal Financial Statements



The principal financial statements have been prepared to report the financial position and results of operations of the National Aeronautics and Space Administration (NASA), pursuant to the requirements of 31 U.S.C. 3515 (b). While the Statements have been prepared from the books and records of NASA in accordance with Generally Accepted Accounting Principles (GAAP) and the formats prescribed by the Office of Management and Budget (OMB) in Circular No. A-136, Financial Reporting Requirements, the statements are in addition to financial reports prepared by the Agency in accordance with OMB and U.S. Department of the Treasury (Treasury) directives to monitor and control the status and use of budgetary resources, which are prepared from the same books and records. The statements should be read with the understanding that they are for a component of the U.S. Government, a sovereign entity. The Agency has no authority to pay liabilities not covered by budgetary resources. Liquidation of such liabilities requires enactment of an appropriation. Comparative data for 2008 are included where available. The financial statements, which describe the results of Agency operations and the Agency's financial position, are the responsibility of NASA's management. NASA's Principal Financial Statements include the following:

The **Consolidated Balance Sheet** provides information on assets, liabilities, and net position as of the end of the year, similar to balance sheets reported in the private sector. Assets must equal the sum of liabilities and net position.

The **Consolidated Statement of Net Cost** reports the components of the net costs of the Agency's operations for the period. The net cost of operations consists of the gross cost incurred by the Agency less any exchange (i.e., earned) revenue from activities.

The **Consolidated Statement of Changes in Net Position** reports the beginning net position, the transactions that affect net position for the period, and the ending net position.

The **Combined Statement of Budgetary Resources** provides information on how budgetary resources were made available and their status for the period. Information in this statement is reported on the budgetary basis of accounting.

Required Supplementary Stewardship Information provides information on the Agency's Research and Development costs.

Required Supplementary Information contains a Combined Statement of Budgetary Resources and information on Deferred Maintenance.

Limitations of the Financial Statements

The principal financial statements have been prepared to report the financial position and results of operation of NASA, pursuant to the requirements of 31 U.S.C. 3515 (b). While the statements have been prepared from the books and records of NASA in accordance with Generally Accepted Accounting Principles (GAAP) for Federal entities and the formats prescribed by the Office of Management and Budget (OMB), the statements are in addition to the financial reports used to monitor and control budgetary resources, which are prepared from the same books and records.

The statements should be read with the realization that they are for a component of the U.S. Government, a sovereign entity.

Financial Statements, Notes, and Supplemental Information

National Aeronautics and Space Administration Consolidated Balance Sheet As of September 30, 2009 and September 30, 2008 (In Millions of Dollars)

	Unaudited 2009	Restated Unaudited 2008
Assets (Note 2):		
Intragovernmental:		
Fund Balance with Treasury (Note 3)	\$ 8,854	\$ 9,292
Investments (Note 4)	17	17
Accounts Receivable (Note 5)	216	74
Total Intragovernmental	9,087	9,383
Accounts Receivable, Net (Note 5)	2	2
Inventory and Related Property, Net (Note 6)	3,019	2,883
Property, Plant and Equipment, Net (Note 7)	11,577	15,028
Total Assets	\$ 23,685	\$ 27,296
Stewardship PP&E (Note 8)		
Liabilities (Note 9):		
Intragovernmental:		
Accounts Payable	\$ 130	\$ 102
Other Liabilities (Note 11)	153	109
Total Intragovernmental	283	211
Accounts Payable	1,254	1,415
Federal Employee and Veteran Benefits	57	64
Environmental and Disposal Liabilities (Note 10)	922	943
Other Liabilities (Note 11)	1,633	1,615
Total Liabilities	4,149	4,248
Commitments and Contingencies (Note 12)		
Net Position:		
Unexpended Appropriations	6,128	6,389
Cumulative Results of Operations	13,408	16,659
Total Net Position	19,536	23,048
Total Liabilities and Net Position	\$ 23,685	\$ 27,296

The accompanying notes are an integral part of this statement.

National Aeronautics and Space Administration
Consolidated Statement of Net Cost
As of September 30, 2009 and September 30, 2008
(In Millions of Dollars)

	Unaudited 2009	Unaudited 2008
Cost by Business Line (Note 13):		
Aeronautics Research		
Gross Costs	\$ 828	\$ 779
Less: Earned Revenue	113	86
Net Costs	715	693
Exploration Systems		
Gross Costs	5,153	4,811
Less: Earned Revenue	33	28
Net Costs	5,120	4,783
Science		
Gross Costs	6,606	6,392
Less: Earned Revenue	616	511
Net Costs	5,990	5,881
Space Operations		
Gross Costs	11,070	7,449
Less: Earned Revenue	428	418
Net Costs	10,642	7,031
Net Cost of Operations	\$ 22,467	\$ 18,388

The accompanying notes are an integral part of this statement.

National Aeronautics and Space Administration
Consolidated Statement of Changes in Net Position
As of September 30, 2009 and September 30, 2008
(In Millions of Dollars)

	Unaudited 2009	Restated Unaudited 2008
Cumulative Results Of Operations:		
Beginning Balances	\$ 16,659	\$ 23,242
Adjustments:		
Correction of Errors (Note 17)	-	(6,580)
Beginning Balances, As Adjusted	<u>16,659</u>	<u>16,662</u>
Budgetary Financing Sources:		
Appropriations Used	18,996	18,240
Nonexchange Revenue	8	6
Other Financing Sources:		
Donations and Forfeitures of Property	10	-
Transfers In/Out Without Reimbursement	57	2
Imputed Financing	151	143
Other	(6)	(6)
Total Financing Sources	<u>19,216</u>	<u>18,385</u>
Net Cost of Operations	<u>(22,467)</u>	<u>(18,388)</u>
Net Change	<u>(3,251)</u>	<u>(3)</u>
Cumulative Results of Operations	<u>13,408</u>	<u>16,659</u>
Unexpended Appropriations:		
Beginning Balance	6,389	7,470
Budgetary Financing Sources:		
Appropriations Received	18,784	17,402
Other Adjustments	(49)	(243)
Appropriations Used	<u>(18,996)</u>	<u>(18,240)</u>
Total Budgetary Financing Sources	<u>(261)</u>	<u>(1,081)</u>
Unexpended Appropriations	<u>6,128</u>	<u>6,389</u>
Net Position	<u>\$ 19,536</u>	<u>\$ 23,048</u>

The accompanying notes are an integral part of this statement.

National Aeronautics and Space Administration
Combined Statement of Budgetary Resources
As of September 30, 2009 and September 30, 2008
(In Millions of Dollars)

	Unaudited 2009	Unaudited 2008
Budgetary Resources:		
Unobligated Balance, Brought Forward, October 1:	\$ 994	\$ 2,594
Recoveries of Prior Year Unpaid Obligations	328	548
Budgetary Authority		
Appropriation	18,786	17,403
Spending Authority from Offsetting Collections:		
Earned		
Collected	1,105	1,120
Change in Receivables from Federal Sources	141	(64)
Change in Unfilled Customer Orders		
Advance Received	27	(7)
Without Advance from Federal Sources	165	(58)
Subtotal	20,224	18,394
Permanently Not Available		
Cancellations of Expired and No-year Accounts	(49)	(51)
Enacted Reductions	-	(192)
	-	-
Total Budgetary Resources	\$ 21,497	\$ 21,293
Status of Budgetary Resources:		
Obligations Incurred (Note 14):		
Direct	\$ 18,702	\$ 19,177
Reimbursable	1,475	1,122
Subtotal	20,177	20,299
Unobligated Balance:		
Apportioned	1,130	786
Unobligated Balance Not Available	190	208
	-	-
Total Status of Budgetary Resources	\$ 21,497	\$ 21,293

The accompanying notes are an integral part of this statement.

National Aeronautics and Space Administration
Combined Statement of Budgetary Resources (Continued)
As of September 30, 2009, and September 30, 2008
(In Millions of Dollars)

	Unaudited 2009	Unaudited 2008
Change in Obligated Balance:		
Obligated Balances, Net		
Unpaid Obligations Brought Forward, October 1	\$ 8,975	\$ 8,176
Less: Uncollected Customer Payments from Federal Sources, Brought Forward, October 1	676	798
Total Unpaid Obligated Balances, Net	8,299	7,378
Obligations Incurred, Net	20,177	20,299
Less: Gross Outlays	20,309	18,952
Less: Recoveries of Prior Year Unpaid Obligations, Actual	328	548
Change in Uncollected Customer Payments from Federal Sources	(306)	122
	\$ 7,533	\$ 8,299
Obligated Balance, Net, End of Period		
Unpaid Obligations	\$ 8,516	\$ 8,975
Less: Uncollected Customer Payments from Federal Sources	983	676
Total, Unpaid Obligated Balance, Net, End of Period	\$ 7,533	\$ 8,299
Net Outlays:		
Net Outlays:		
Gross Outlays	\$ 20,313	\$ 18,952
Less: Offsetting Collections	1,136	1,113
Less: Distributed Offsetting Receipts	1	(1)
Net Outlays	\$ 19,176	\$ 17,840

The accompanying notes are an integral part of this statement.

National Aeronautics and Space Administration
Notes to Financial Statements
(Fiscal Years 2009 and 2008 are Unaudited)

NOTE 1. SUMMARY OF SIGNIFICANT ACCOUNTING POLICIES

Reporting Entity

The National Aeronautics and Space Administration (NASA) is an independent Agency established by Congress on October 1, 1958 by the National Aeronautics and Space Act of 1958. NASA was incorporated from the Agency's predecessor organization, the National Advisory Committee for Aeronautics, which provided technical advice to the United States aviation industry and performed aeronautics research. Today, NASA serves as the fulcrum for initiatives by the United States in civil space and aviation.

NASA is organized into four Business Lines which focus on the following objectives:

- Aeronautics Research: conducting research which will significantly enhance aircraft performance, environmental compatibility, and safety, and will enhance the capacity, flexibility, and safety of the future air transportation system;
- Exploration Systems: creating new capabilities, supporting technologies and foundational research for affordable, sustainable human and robotic exploration;
- Science: exploring the Earth, Moon, Mars, and beyond; charting the best route of discovery, and reaping the benefits of Earth and space exploration for society; and
- Space Operations: providing critical enabling technologies for much of the rest of NASA through the Space Shuttle, the International Space Station, and flight support.

In addition, NASA has nine support offices, including the Office of the Chief Financial Officer and Institutions & Management. The Agency's structure includes a Strategic Management Council, an Operations Management Council and a Program Management Council to integrate NASA's strategic, tactical and operational decisions, and a number of other committees supporting NASA's focus and direction. The organizational structure is designed to streamline and position the Agency to better implement the Vision for Space Exploration.

The nine NASA Centers, NASA Headquarters, and the Jet Propulsion Laboratory carry out the activities of the Mission Directorates. The Jet Propulsion Laboratory is a federally funded Research and Development center owned by NASA but managed by an independent contractor.

NASA Shared Services Center (NSSC) opened March 1, 2006 on the grounds of Stennis Space Center. The NSSC is a public/private partnership between NASA and Computer Sciences Corporation service providers. The mixed staff of civil service and contractor personnel performs a variety of consolidated transactional and administrative activities once carried out at each NASA center and Headquarters. These functions consisted of responsibilities in the following areas: Financial Management, Human Resources, Information Technology and Procurement.

The accompanying financial statements of NASA include the accounts of all funds which have been established and maintained to account for the resources under the control of NASA management.

Basis of Accounting and Presentation

These consolidated financial statements are prepared in accordance with generally accepted accounting principles (GAAP) in the United States of America and standards as promulgated by the Federal Accounting Standards Advisory Board (FASAB) and the Office of Management and Budget (OMB) Circular No. A-136, *Financial Reporting Requirements, Revised (June 10, 2009)*. FASAB is recognized by the American Institute of Certified Public Accountants (AICPA) as the official accounting standards-setting body for United States government entities. The statements present the financial position, net cost of operations, changes in net position, and budgetary resources of NASA, as required by the Chief Financial Officers Act of 1990, Public Law (P.L.) 101-576, and the Government Management Reform Act of 1994 (P.L. 101-356).

National Aeronautics and Space Administration
Notes to Financial Statements
(Fiscal Years 2009 and 2008 are Unaudited)

NOTE 1. SUMMARY OF SIGNIFICANT ACCOUNTING POLICIES (CONTINUED)

The financial statements should be read with the realization they are a component of the U.S. government, a sovereign entity. One implication of this is that liabilities cannot be liquidated without legislation providing resources and legal authority to do so. The accounting structure of Federal agencies is designed to reflect both accrual and budgetary accounting transactions. Under the accrual method of accounting, revenues are recognized when earned and expenses are recognized when a liability is incurred, without regard to receipt or payment of cash. Budgetary accounting facilitates compliance with legal constraints and controls over the use of Federal funds.

Budgets and Budgetary Accounting

NASA follows standard Federal budgetary accounting policies and practices in accordance with OMB Circular No. A-11, Preparation, Submission and Execution of the Budget. Budgetary accounting facilitates compliance with legal constraints and controls over the use of Federal funds. Congress funds NASA through seven main appropriations: Science, Aeronautics, Exploration, Space Operations, Education, Cross-Agency Support and Inspector General to accomplish the goals of the Agency's Business Lines. In 2009, NASA also received funding under the American Recovery and Reinvestment Act of 2009 through five appropriations: Science Recovery Act, Aeronautics Recovery Act, Exploration Recovery Act, Cross-Agency Support Recovery Act and Inspector General Recovery Act. Reimbursements to NASA are used to fund agreements between the Agency and other Federal entities or the Public. As part of its reimbursable program, NASA launches devices into space and provides tracking and data relay services for the U.S. Department of Defense and the Department of Commerce (National Oceanic and Atmospheric Administration).

Research and Development and Similar Costs

NASA makes substantial Research and Development (R&D) investments for the benefit of the United States. NASA's R&D programs include activities to extend our knowledge of Earth, its space environment, and the universe; and to invest in new aeronautics and advanced space transportation technologies supporting the development and application of technologies critical to the economic, scientific, and technical competitiveness of the United States. Accordingly, NASA applies the Financial Accounting Standard Board's (FASB) Accounting Standards Codification (ASC) 730-10-25, *Research and Development-Recognition*, and FASB ASC 730-10-50 *Research and Development- Disclosure*, to its R&D projects.

Use of Estimates

The preparation of financial statements requires management to make estimates and assumptions affecting the reported amounts of assets and liabilities as of the date of the financial statements and the reported amounts of revenues and expenses during the reporting period. Actual results could differ from these estimates.

NASA requires major contractors to provide an estimate of their anticipated billing prior to their sending the actual invoice to the agency. In addition, NASA requires the contractors to provide an estimate for the next month's anticipated work. When NASA receives these estimates they are compared to the contract under which the work is performed. If the estimate exceeds a specified funding line item the program manager and the procurement official, as necessary, review the estimate prior to posting in the general ledger as an estimated liability. If the review is not completed within the timeframe for quarterly or yearly reporting, the Agency uses the estimates of activity through the current period to establish an estimated liability. However, in this instance the agency fully recognizes that "no agency has the authority to pay liabilities not covered by budgetary resources." Liability to the contractor is not established by receipt of these estimates, but only when accepted by the Agency.

Fund Balance with Treasury

The Department of the Treasury (Treasury) processes cash receipts and disbursements for NASA. Fund Balance with Treasury includes general funds, trust funds, deposit funds, and budget clearing accounts.

National Aeronautics and Space Administration
Notes to Financial Statements
(Fiscal Years 2009 and 2008 are Unaudited)

NOTE 1. SUMMARY OF SIGNIFICANT ACCOUNTING POLICIES (CONTINUED)

Investments in U.S. Government Securities

Investments include the following Intragovernmental non-marketable securities:

(1) National Aeronautics and Space Administration Endeavor Teacher Fellowship Trust Fund established from public donations in tribute to the crew of the Space Shuttle Challenger.

(2) Science, Space and Technology Education (Challenger) Trust Fund established for programs to improve science and technology education.

The Endeavor Trust Fund balance is invested in short-term bills, while the Challenger Trust Fund balance is invested in short-term bills and long-term bonds. P.L. 100-404 requires a quarterly payment of \$250,000 is sent to the Challenger Center from interest earned on the Challenger investments. In order to meet the requirement of providing funds to the Challenger Center, NASA invests the bi-annual interest earned in short-term bills that mature in order to provide \$250,000 at the end of every quarter. Any interest received and not needed for the quarterly payment to the Challenger Center is invested in a bond maturing on February 15, 2019.

P.L. 102-195 requires the interest earned from the Endeavor investments be used to create the Endeavor Teacher Fellowship Program; however, there have been no funds obligated for this purpose to date.

Accounts Receivable

Most receivables are for intra-governmental reimbursements of research and development costs related to satellites and launch services. A small portion of NASA accounts receivable are debts to the Agency by the non-Federal government entities. Allowances for doubtful non-Federal accounts are based on factors such as, aging of accounts receivable, debtors' ability to pay, payment history, and other relevant factors. Also, doubtful non-federal debts over 180 days are referred to the Treasury Department for collection or cross-servicing. Under the cross-servicing program, Treasury can withhold payments due from Treasury to a non-Federal debtor to the extent of debt owed to the Federal government. The accounts receivable due to non-Federal debt remain on NASA books as assets until Treasury determines that they are uncollectible, at which point they are written off.

Inventory and Related Property

Inventory held by Centers and contractors repetitively procured, stored and issued on the basis of demand are considered Operating Materials and Supplies, a category of Inventory and Related Property. Certain NASA contractors' inventory management systems do not distinguish between items to be properly classified as materials and those to be properly classified as depreciable property. NASA reclassifies as property, all re-usable materials valued at \$100,000 or greater with a useful life of 2 years or more, in support of large-scale assets such as the Space Shuttle and the International Space Station.

Property, Plant and Equipment

These financial statements report depreciation expense using the straight-line method, using the mid-year convention when assets are placed into service for all categories of PP&E. Property with a unit cost of \$100,000 or more and a useful life of 2 years or more and an alternative future use is capitalized. Capitalized costs include costs incurred by NASA to bring the property to a form and location suitable for its intended use. Under provisions of the Federal Acquisition Regulation (FAR), contractors are responsible for control over and accountability for Government-owned property in their possession.

National Aeronautics and Space Administration
Notes to Financial Statements
(Fiscal Years 2009 and 2008 are Unaudited)

NOTE 1. SUMMARY OF SIGNIFICANT ACCOUNTING POLICIES (CONTINUED)

Capitalized costs for internally developed software include the full costs (direct and indirect) incurred during the software development stage only. For purchased software, capitalized costs include amounts paid to vendors for the software and material internal costs incurred by the Agency to implement and make the software ready for use through acceptance testing. When NASA purchases software as part of a package of products and services (for example: training, maintenance, data conversion, reengineering, site licenses, and rights to future upgrades and enhancements), capitalized and non-capitalized costs of the

package are allocated among individual elements on the basis of a reasonable estimate of their relative fair market values. Costs not susceptible to allocation between maintenance and relatively minor enhancements are expensed.

NASA capitalizes costs for internal use software when the total projected cost is \$1,000,000 or more and the expected useful life of the software is 5 years or more.

NASA began depreciating the International Space Station in Fiscal Year (FY) 2001 when manned by the first permanent crew. Only the Station's major elements in space are depreciated; any on-ground elements are reported as Assets Under Construction (AUC) until launched and incorporated into the existing Station structure.

Liabilities Covered by Budgetary Resources

Liabilities covered by budgetary resources are liabilities covered by realized budgetary resources as of the balance sheet date. Realized budgetary resources include new budget authority, unobligated balances of budgetary resources at the beginning of the year, and spending authority from offsetting collections. Examples include accounts payable and salaries. Accounts Payable includes amounts recorded for the receipt of goods or services received.

Liabilities and Contingencies Not Covered by Budgetary Resources

Generally liabilities not covered by budgetary resources are liabilities for which Congressional action is needed before budgetary resources can be provided. Liabilities not covered by budgetary resources include certain environmental matters, legal claims, pensions and other retirement benefits (ORB), workers' compensation, annual leave, and closed appropriations.

Federal Employee and Veterans' Benefits

A liability was recorded for workers' compensation claims related to the Federal Employees' Compensation Act (FECA), administered by the U.S. Department of Labor. The FECA provides income and medical cost protection to covered Federal civilian employees injured on the job, employees who have incurred a work-related occupational disease, and beneficiaries of employees whose death is attributable to a job-related injury or occupational disease. The FECA Program initially pays valid claims and subsequently seeks reimbursement from the Federal agencies employing the claimants.

The FECA liability includes the actuarial liability for estimated future costs of death benefits, workers' compensation, and medical and miscellaneous costs for approved compensation cases. This liability is reported on the Federal Employee and Veteran Benefits line on the balance sheet. The present value of these estimates at year-end was calculated by the Department of Labor using a discount rate of 4.22% in FY 2009 and 4.37% in FY 2008. This liability includes the estimated future costs for claims incurred but not reported or approved as of the end of each year.

Personnel Compensation and Benefits

Annual Sick and Other Leave

Annual leave is accrued as it is earned; the accrual is reduced as leave is taken. Each year, the balance in the accrued annual leave account is adjusted to reflect current pay rates. To the extent current or prior year appropriations are not available to fund annual leave earned but not taken, funding will be obtained from future financing sources. Sick leave and other types of non-vested leave are expensed as taken.

National Aeronautics and Space Administration
Notes to Financial Statements
(Fiscal Years 2009 and 2008 are Unaudited)

NOTE 1. SUMMARY OF SIGNIFICANT ACCOUNTING POLICIES (CONTINUED)

Retirement Benefits

Agency employees participate in the Civil Service Retirement System (CSRS), a defined benefit plan, or the Federal Employees Retirement System (FERS), a defined benefit and contribution plan. For CSRS employees, NASA makes contributions of 7.0 percent of pay. For FERS employees, NASA makes contributions of 11.2 percent to the defined benefit plan, contributes 1 percent of pay to a retirement saving plan (contribution plan), and matches employee contributions up to an additional 4 percent of pay. For FERS employees, NASA also contributes to employer's matching share for Social Security taxes.

Insurance Benefits

The Federal Accounting Standards Advisory Board's Statement of Federal Financial Accounting Standards (SFFAS) No. 5, *Accounting for Liabilities of the Federal Government*, requires Government agencies to report the full cost of Federal Employee Health Benefits (FEHB), and the Federal Employees Group Life Insurance (FEGLI) Programs. NASA uses the applicable cost factors and imputed financing sources provided by the Office of Personnel and Management.

Environmental and Disposal Liabilities

Environmental and Disposal Liabilities represent anticipated cleanup costs resulting from: (1) operations that include facilities obtained from other governmental entities as well, that have resulted in contamination from waste disposal methods, leaks, spills, and other past activity that created a public health or environmental risk; and, (2) estimated total cleanup costs associated with the removal, containment, and/or disposal of hazardous wastes or material and/or property that have been deferred until operation of associated PP&E ceases either permanently or temporarily. An annual determination is made of the status of these unfunded liabilities.

NASA changed its estimate for FY 2009 to meet its new guidance for developing long term estimates. The guidance establishes the estimate amount as both probable and reasonably estimable for 30 years. If a sufficiently reliable engineering estimate has been developed beyond this 30 year period, such estimate will be considered in developing the accrual.

Other

Certain amounts for fiscal year 2008 have been reclassified to be consistent with fiscal year 2009 presentation.

National Aeronautics and Space Administration
Notes to Financial Statements
(Fiscal Years 2009 and 2008 are Unaudited)

NOTE 2. NON-ENTITY ASSETS

Non-Entity Assets are those assets held by NASA, but are not available for use by NASA.

(In Millions of Dollars)	2009	2008
Intragovernmental:		
Fund Balance with Treasury	\$ 0	\$ 0
Total Intragovernmental	<u>0</u>	<u>0</u>
Total Non-Entity Assets	0	0
Total Entity Assets	<u>23,685</u>	<u>27,296</u>
Total Assets	<u>\$ 23,685</u>	<u>\$ 27,296</u>

National Aeronautics and Space Administration
Notes to Financial Statements
(Fiscal Years 2009 and 2008 are Unaudited)

NOTE 3. FUND BALANCE WITH TREASURY

Fund Balance with Treasury represents the aggregate amount of the Agency's funds held on deposit with the U.S. Treasury that are available to pay liabilities. The fund types include trust, general and revolving funds and other funds.

Trust Funds include balances in Endeavor Teacher Fellowship Trust Fund; National Space Grant Program; Science, Space and Technology Education Trust Fund; and Gifts and Donations.

General Funds primarily consists of appropriated funds for the Agency.

Other Fund types include Working Capital Fund; Fines, Penalties, and Forfeitures; General Fund Proprietary Interest; Collections of Receivables from Canceled Appropriations; General Fund Proprietary Receipts; Budget Clearing and Suspense; Unavailable Check Cancellation; Undistributed Intragovernmental Payment; State and Local Taxes; Other Payroll; and U.S. Employee Allotment Account, Savings Bonds.

(In Millions of Dollars)	2009	2008
Fund Balances:		
Trust Funds	\$ 4	\$ 4
General Funds	8,801	9,242
Other Fund Types	49	46
	<hr/>	<hr/>
Total	\$ 8,854	\$ 9,292
	<hr/> <hr/>	<hr/> <hr/>

The status of Fund Balance with Treasury represents the total fund balance as reflected in the general ledger for unobligated and obligated balances. Unobligated Balances—Available represent the amount remaining in appropriation accounts available for obligation in future fiscal years. Unobligated Balances—Unavailable represent the amount remaining in appropriation accounts only used for adjustments to previously recorded obligations. Obligated Balances—Not Yet Disbursed represent the cumulative amount of obligations incurred, including accounts payable and advances from reimbursable customers, for which outlays have not been made.

(In Millions of Dollars)	2009	2008
Status of Fund Balance with Treasury:		
Unobligated Balance		
Available	\$ 1,130	\$ 786
Unavailable	190	208
Obligated Balance Not Yet Disbursed	7,533	8,299
Clearing and Deposit Accounts	1	(1)
	<hr/>	<hr/>
Total	\$ 8,854	\$ 9,292
	<hr/> <hr/>	<hr/> <hr/>

National Aeronautics and Space Administration
Notes to Financial Statements
(Fiscal Years 2009 and 2008 are Unaudited)

NOTE 4. INVESTMENTS

The Agency's investments consist of non-marketable par value intragovernmental securities issued by Treasury's Bureau of the Public Debt. The trust fund cash balances are invested in Treasury securities, which are purchased and redeemed at par value exclusively through Treasury's Federal Investment Branch. The effective-interest method was utilized to amortize premiums on bonds, and the straight-line method was utilized to amortize discounts on bills.

The amount of Interest Receivable was below the displayable threshold of a million dollars. In addition, the Agency did not have any adjustments resulting from the sale of securities prior to maturity or any change in value that is more than temporary.

		2009						
(In Millions of Dollars)	Cost	Amortization Method	Amortized (Premium) Discount	Interest Receivable	Investments, Net	Other Adjustments	Market Value Disclosure	
Intragovernmental Securities:								
Non-Marketable:								
		Effective-interest and Straight-line						
Par Value	\$ 18	0.185–6.602 %	\$ (1)	\$ —	\$ 17	\$ —	\$ 17	
Total	\$ 18		\$ (1)	\$ —	\$ 17	\$ —	\$ 17	

		2008						
(In Millions of Dollars)	Cost	Amortization Method	Amortized (Premium) Discount	Interest Receivable	Investments, Net	Other Adjustments	Market Value Disclosure	
Intragovernmental Securities:								
Non-Marketable:								
		Effective-interest and Straight-line						
Par Value	\$ 18	0.765–6.602 %	\$ (1)	\$ —	\$ 17	\$ —	\$ 17	
Total	\$ 18		\$ (1)	\$ —	\$ 17	\$ —	\$ 17	

National Aeronautics and Space Administration
Notes to Financial Statements
(Fiscal Years 2009 and 2008 are Unaudited)

NOTE 5. ACCOUNTS RECEIVABLE, NET

The Accounts Receivable balance represents valid claims by NASA to cash or other assets of another entity. Intragovernmental Accounts Receivable represents reimbursements from other Federal entities for goods and services provided by NASA on a reimbursable basis. Accounts Receivable Due from the Public represents miscellaneous debts due to NASA from employees and/or limited reimbursements from other non-Federal entities. A periodic evaluation of public accounts receivable is performed to estimate any uncollectible amounts based on current status, financial and other relevant characteristics of debtors, and the overall relationship with the debtor. An allowance for doubtful accounts is recorded, for Accounts Receivable Due from the Public, in order to bring Accounts Receivable to its Net Realizable Value in accordance with SFFAS No. 1, *Accounting for Selected Assets and Liabilities*.

		2009		
(In Millions of Dollars)		Accounts Receivable	Allowance for Uncollectible Accounts	Net Amount Due
Intragovernmental	\$	216	\$ —	\$ 216
Public		2	—	2
Total	\$	218	\$ —	\$ 218

		2008		
(In Millions of Dollars)		Accounts Receivable	Allowance for Uncollectible Accounts	Net Amount Due
Intragovernmental	\$	74	\$ —	\$ 74
Public		2	—	2
Total	\$	76	\$ —	\$ 76

National Aeronautics and Space Administration
Notes to Financial Statements
(Fiscal Years 2009 and 2008 are Unaudited)

NOTE 6. INVENTORY AND RELATED PROPERTY, NET

Operating Materials and Supplies-Held for Use are tangible personal property to be used in the normal course operations. Operating Materials and Supplies-Held in Reserve for Future Use are tangible personal property held for emergencies.

All materials are valued using historical costs or other valuation methods that approximate historical cost. Excess operating materials and supplies are materials exceeding the demand expected in the normal course of operations, and do not meet management’s criteria to be held in reserve for future use. Excess, Obsolete, and Unserviceable operating material and supplies are materials no longer needed due to changes in technology, laws, customs, or operations. Unserviceable operating materials and supplies are materials damaged beyond economic repair.

(In Millions of Dollars)	2009	2008
Operating Materials and Supplies		
Items Held for Use	\$ 3,016	\$ 2,855
Items Held in Reserve for Future Use	3	3
Excess, Obsolete, and Unserviceable	—	25
	<hr/>	<hr/>
Total	\$ 3,019	\$ 2,883
	<hr/>	<hr/>

National Aeronautics and Space Administration
Notes to Financial Statements
(Fiscal Years 2009 and 2008 are Unaudited)

NOTE 7. PROPERTY, PLANT, AND EQUIPMENT, NET (PP&E)

NASA has International Space Station (ISS) bartering agreements with international entities including the European Space Agency and the National Space Agency of Japan. NASA barter with these space agencies to obtain International Space Station hardware elements in exchange for providing goods and services such as Space Shuttle transportation and a share of the International Space Station utilization rights. The intergovernmental agreements state that the parties will seek to minimize the exchange of funds in the cooperative program, including the use of barter to provide goods and services. As of September 30, 2009, NASA has received some assets from these parties in exchange for future services. The fair value is indeterminable; therefore no value was ascribed to these transactions in accordance with FASB ASC 845-10-25 *Non-Monetary Transactions – Recognition* and ASC 845-10-50 *Non-Monetary Transactions - Disclosure*.

In preparation for the release of SFFAS 35, *Estimating the Historical Cost of General Property, Plant, and Equipment -- Amending Statements of Federal Financial Accounting Standards 6 and 23* NASA performed an analysis of the methodology used to account for the historical costs of ISS the Space Shuttle and Work in Process (WIP). Based on that analysis, adjustments were recorded to ISS and WIP to reflect their estimated cost. Note 17, Restatement reflects the impact of these adjustments on prior periods.

National Aeronautics and Space Administration
Notes to Financial Statements
(Fiscal Years 2009 and 2008 Are Unaudited)

NOTE 7. PROPERTY, PLANT, AND EQUIPMENT, NET (CONTINUED)

2009

(In Millions of Dollars)	Depreciation Method	Useful Life	Cost	Accumulated Depreciation	Book Value
Space Exploration PP&E					
International Space Station	Straight-line	5–20 years	\$ 11,456	\$ (5,758)	\$ 5,698
Space Shuttle	Straight-line	5–20 years	10,055	(9,287)	768
Assets Under Construction		N/A	1,303	—	1,303
Work-in-Process—Equipment		N/A	1,180	—	1,180
Total			23,994	(15,045)	8,949
General PP&E					
Land			122	—	122
Structures, Facilities and Leasehold Improvements	Straight-line	15–40 years	7,790	(5,942)	1,848
Institutional Equipment	Straight-line	5–20 years	259	(185)	74
Construction in Process		N/A	506	—	506
Internal Use Software and Development	Straight-line	5 years	219	(141)	78
Total			8,896	(6,268)	2,628
Total Property, Plant, and Equipment			\$ 32,890	\$ (21,313)	\$ 11,577

Restated 2008

(In Millions of Dollars)	Depreciation Method	Useful Life	Cost	Accumulated Depreciation	Book Value
Space Exploration PP&E					
International Space Station	Straight-line	5–20 years	\$ 10,800	\$ (3,848)	\$ 6,952
Space Shuttle	Straight-line	5–20 years	9,880	(9,134)	746
Assets Under Construction		N/A	1,661	—	1,661
Work-in-Process—Equipment		N/A	3,168	—	3,168
Total			25,509	(12,982)	12,527
General PP&E					
Land			123	—	123
Structures, Facilities and Leasehold Improvements	Straight-line	15–40 years	7,163	(5,530)	1,633
Institutional Equipment	Straight-line	5–20 years	244	(173)	71
Construction in Process		N/A	577	—	577
Internal Use Software and Development	Straight-line	5 years	214	(117)	97
Total			8,321	(5,820)	2,501
Total Property, Plant, and Equipment			\$ 33,830	\$ (18,802)	\$ 15,028

National Aeronautics and Space Administration
Notes to Financial Statements
(Fiscal Years 2009 and 2008 are Unaudited)

NOTE 8. STEWARDSHIP PP&E

Federal agencies are required to classify and report heritage assets, in accordance with the requirements of SFFAS No. 29, *Heritage Assets and Stewardship Land*.

Stewardship PP&E consists of items whose physical properties resemble those of general PP&E, but their nature differs in that their values may be indeterminable or have little meaning, or that allocating the cost of such assets (depreciation) to accounting periods is meaningless. The only type of stewardship PP&E owned by NASA are heritage assets.

Heritage assets are property, plant, and equipment which possess one or more of the following characteristics: historical or natural significance; cultural, educational, or aesthetic value; or significant architectural characteristics. NASA's heritage assets include buildings and structures designated as National Historic Landmarks and air and spacecraft and related components on display to enhance public understanding of NASA programs.

Since the cost of heritage assets is usually not determinable, NASA does not value them or establish minimum value thresholds for designation of property, plant, or equipment as heritage assets. Additionally, the useful lives of heritage assets are not reasonably estimable for depreciation purposes. Since the most relevant information about heritage assets is their existence, they are qualified in terms of physical units, as follows:

	2008	Additions	Withdrawals	2009
Buildings and Structures	18	0	6	12
Air and Space Displays and Artifacts	521	8	6	523
Art and Miscellaneous Items	1,015	0	1	1,014
Total Heritage Assets	1,554	8	13	1,549
	2007	Additions	Withdrawals	2008
Buildings and Structures	18	1	1	18
Air and Space Displays and Artifacts	526	6	11	521
Art and Miscellaneous Items	1,018	5	8	1,015
Total Heritage Assets	1,562	12	20	1,554

Heritage assets were generally acquired through construction by NASA or its contractors, and are expected to remain in this category, except where there is legal authority for transfer or sale. Heritage assets are generally in fair condition, suitable only for display. Heritage assets are withdrawn when they become inactive or multi-use heritage assets.

Many of the buildings and structures are designated as National Historic Landmarks. Numerous air and spacecraft and related components are on display at various locations to enhance public understanding of NASA programs. NASA eliminated their cost from its property records when they were designated as heritage assets. A portion of the amount reported for deferred maintenance is for heritage assets.

For more than 30 years, the NASA Art Program has documented America's major accomplishments in aeronautics and space. During that time, artists have generously contributed their time and talent to record their impressions of the U.S. Aerospace Program in paintings, drawings, and other media. Not only do these art works provide a historic record of NASA projects, they give the public a new and fuller understanding of advancements in aerospace. Artists give a special view of NASA through the back door. Some have witnessed astronauts in training or scientists at work. The art collection, as a whole, depicts a wide range of subjects, from Space Shuttle launches to aeronautics research, the Hubble Space Telescope, and even virtual reality.

National Aeronautics and Space Administration
Notes to Financial Statements
(Fiscal Years 2009 and 2008 are Unaudited)

NOTE 8. STEWARDSHIP PP&E (CONTINUED)

Artists commissioned by NASA receive a small honorarium in exchange for donating a minimum of one piece to the NASA archive. In addition, more works have been donated to the National Air and Space Museum.

In accordance with SFFAS No. 29, the cost of acquisition, improvement, reconstruction, or renovation of heritage assets is expensed in the period incurred.

As defined by SFFAS No. 29, heritage assets that are used in day-to-day government operations are considered "multi-use" heritage assets that are not used for heritage purposes. Such assets are accounted for as general property, plant, and equipment and are capitalized and depreciated in the same manner as other general property, plant, and equipment. For FY 2009 NASA had 89 buildings, structures, and equipment that are considered to be multi-use heritage assets. The values of these assets are included in the property, plant, and equipment values shown in the Financial Statements and Note 7, Property, Plant, and Equipment, Net.

National Aeronautics and Space Administration
Notes to Financial Statements
(Fiscal Years 2009 and 2008 are Unaudited)

NOTE 9. LIABILITIES NOT COVERED BY BUDGETARY RESOURCES

Liabilities not covered by budgetary resources are liabilities for which Congressional action is needed before budgetary resources can be provided. They include certain environmental matters (Note 10, Environmental and Disposal Liabilities), legal claims, pensions and other retirement benefits, workers' compensation, annual leave, and closed appropriations.

NASA has recorded Accounts Payable related to closed appropriations for which there are contractual commitments to pay. These payables will be funded from appropriations available for obligation at the time a bill is processed, in accordance with P.L. 101-510, National Defense Authorization Act for Fiscal Year 1991.

(In Millions of Dollars)	2009	2008
Intragovernmental Liabilities:		
Other Liabilities		
Workers' Compensation	\$ 14	\$ 16
Accounts Payable for Closed Appropriations	8	7
Total Intragovernmental	<u>22</u>	<u>23</u>
Public Liabilities:		
Accounts Payable		
Accounts Payable for Closed Appropriations	34	71
Federal Employee and Veteran Benefits		
Actuarial FECA Liability	57	64
Environmental and Disposal Liabilities	922	943
Other Liabilities		
Unfunded Annual Leave	208	196
Contingent Liabilities	—	6
Total Liabilities Not Covered by Budgetary Resources	1,243	1,303
Total Liabilities Covered by Budgetary Resources	2,906	2,945
Total Liabilities	\$ 4,149	\$ 4,248

National Aeronautics and Space Administration
Notes to Financial Statements
(Fiscal Years 2009 and 2008 are Unaudited)

NOTE 10. ENVIRONMENTAL AND DISPOSAL LIABILITIES

(in Millions of Dollars)	2009	2008
Probable		
Known Hazardous Conditions	\$ 812	\$ 943
Anticipated Cleanup at Disposal: Space Shuttle	110	—
Total	\$ 922	\$ 943
Reasonably Possible		
Known Hazardous Conditions	\$ 17	\$ 93
Anticipated Cleanup at Disposal: Space Shuttle	54	—
Anticipated Cleanup at Disposal: Other PP&E	7 - 19	—
Total	\$ 78 - 90	\$ 93

Environmental and Disposal Liabilities represents cleanup costs resulting from:

- Operations that include facilities obtained from other governmental entities that have resulted in contamination from waste disposal methods, leaks and spills.
- Other past activity that created a public health or environmental risk.
- Total cleanup costs associated with the removal, containment, and/or disposal of hazardous wastes or material and/or property that have been deferred until operation of associated Property, Plant, and Equipment (PP&E) ceases either permanently or temporarily.

Federal, State, and local statutes and regulations require environmental cleanup. Some of these statutes include: the Comprehensive Environmental Response, Compensation, and Liability Act; the Resource Conservation and Recovery Act; the Nuclear Waste Policy Act of 1982; as well as State and local laws.

NASA assesses the likelihood of required cleanup as probable, reasonably possible or remote. If the likelihood of required cleanup is probable and the cost can be reasonably estimated, a liability is recorded in the financial statements. If the likelihood of required cleanup is reasonably possible, the estimated cost of cleanup is disclosed in the notes to the financial statements. If the likelihood of required cleanup is remote, no liability is recorded or estimate disclosed.

If site-specific engineering estimates for cleanup are not available, NASA employs parametric modeling software to estimate the total cost of cleaning up known contamination at these sites for current and future years. The estimates calculated by the parametric models may be classified as probable or reasonably possible.

Consistent with Statement of Federal Financial Accounting Standards No. 6, *Accounting for Property, Plant, and Equipment*, NASA estimates the anticipated environmental disposal cleanup costs for current and planned capital property, plant and equipment (PP&E). NASA recognizes and records in its financial statements an environmental cleanup liability for those in-service PP&E with a probable and measurable environmental cleanup liability of \$100,000 or more.

Probable Environmental and Disposal Liabilities

In FY 2009, NASA recorded \$812 million as an unfunded liability to reflect the estimated total cost of environmental cleanup on known hazardous conditions. The amount recorded in FY 2008 was \$943 million. The decrease is due to changes in individual project estimates and the treatment of estimates beyond 30 years. If a sufficiently reliable engineering estimate has been developed beyond this 30 year period, such estimate will be considered in developing the accrual (see Note 1). The estimate could change in the future due to identification of additional contamination, inflation, deflation, or a change in technology or applicable laws and regulations as well as through ordinary liquidation of these liabilities as the cleanup program continues into the future. Estimates change primarily due to updated information being available on the extent of contamination and remediation efforts that would be required.

National Aeronautics and Space Administration
Notes to Financial Statements
(Fiscal Years 2009 and 2008 are Unaudited)

NOTE 10. ENVIRONMENTAL AND DISPOSAL LIABILITIES

NASA has developed an estimated cost for decontamination of the Space Shuttles at the time of their retirement in FY 2010. Current estimates indicate probable unfunded cleanup costs at the time of disposal through FY 2012 of \$110 million.

Reasonably Possible Environmental and Disposal Liabilities

In addition to the probable cleanup costs for known hazardous conditions recognized in the financial statements, there are other potential remediation sites where the likelihood of required cleanup for known hazardous conditions is reasonably possible. FY 2009 remediation costs at certain sites classified as reasonably possible were estimated at \$17 million. In FY 2008, these remediation costs were estimated at \$93 million.

NASA estimated \$1 million of Space Shuttle disposal costs (for the periods FY 2013 through FY 2015) as reasonably possible. Additionally, costs necessary to cleanup Space Shuttle equipment for museum display are expected to be the responsibility of the institution displaying the equipment. If NASA is required to incur those additional costs, then costs may increase by \$53 million.

Current estimates indicate a reasonable possibility that disposal-related cleanup costs for PP&E other than Space Shuttle may result in total environmental cleanup costs of between \$7 million and \$19 million. Consistent with NASA's approach described above, this reasonably possible estimate is not recorded but is disclosed in the financial statements.

The International Space Station (ISS) is designed and planned to be de-orbited over the Pacific Ocean. The ISS will be destroyed during reentry. Accordingly, no end-of-life environmental liability is anticipated for the ISS.

National Aeronautics and Space Administration
Notes to Financial Statements
(Fiscal Years 2009 and 2008 are Unaudited)

NOTE 11. OTHER LIABILITIES

2009			
(In Millions of Dollars)	Current	Non-Current	Total
Intragovernmental Liabilities			
Advances from Others	\$ 110	\$ —	\$ 110
Workers' Compensation	5	9	14
Employer Contributions and Payroll Taxes	22	—	22
Liability for Deposit and Clearing Funds	1	—	1
Liability for Non-Entity Assets Not Reported on the Statement of Custodial Activity	—	—	—
Other Accrued Liabilities	6	—	6
Total Intragovernmental	144	9	153
Unfunded Annual Leave	—	208	208
Accrued Funded Payroll	106	—	106
Advances from Others	57	—	57
Employer Contributions and Payroll Taxes	4	—	4
Contract Holdbacks	—	—	—
Contingent Liabilities	—	—	—
Other Accrued Liabilities	1,258	—	1,258
Total with the Public	1,425	208	1,633
Total Other Liabilities	\$ 1,569	\$ 217	\$ 1,786
2008			
(In Millions of Dollars)	Current	Non-Current	Total
Intragovernmental Liabilities			
Advances from Others	\$ 79	\$ —	\$ 79
Workers' Compensation	7	9	16
Employer Contributions and Payroll Taxes	14	—	14
Liability for Deposit and Clearing Funds	(1)	—	(1)
Other Accrued Liabilities	1	—	1
Total Intragovernmental	100	9	109
Unfunded Annual Leave	—	196	196
Accrued Funded Payroll	90	—	90
Advances from Others	62	—	62
Employer Contributions and Payroll Taxes	22	—	22
Contract Holdbacks	1	—	1
Contingent Liabilities	—	6	6
Other Accrued Liabilities	1,238	—	1,238
Total with the Public	1,413	202	1,615
Total Other Liabilities	\$ 1,513	\$ 211	\$ 1,724

National Aeronautics and Space Administration
Notes to Financial Statements
(Fiscal Years 2009 and 2008 are Unaudited)

NOTE 12. CONTINGENT LIABILITIES

NASA is a party in various administrative proceedings, court actions (including tort suits), and claims. For cases management and legal counsel believe it is probable that the outcomes will result in a loss to the Agency, liabilities have been recorded for September 30, 2009 and September 30, 2008 in the amounts of \$0 million and \$6 million, respectively. There were certain cases reviewed by legal counsel where the probable future loss could not be reasonably estimated and as such no liability has been recorded in connection with these cases.

There is one case where the likelihood of loss is reasonably possible, with the loss estimated at \$20 million for September 30, 2009 and a range of loss from \$1 million to \$10 million for September 30, 2008.

National Aeronautics and Space Administration
Notes to Financial Statements
(Fiscal Years 2009 and 2008 are Unaudited)

NOTE 13. INTRAGOVERNMENTAL COST AND EXCHANGE REVENUE

Intragovernmental costs and revenue are exchange transactions made between NASA and another Federal Government reporting entity. Costs and revenue with the Public result from transactions between NASA and a non-Federal entity.

(In Millions of Dollars)	2009	2008
Aeronautics Research		
Intragovernmental Costs	\$ 43	\$ 52
Public Cost	785	727
Total Aeronautics Research Costs	828	779
Intragovernmental Earned Revenue	94	62
Public Earned Revenue	19	24
Total Aeronautics Research Earned Revenue	113	86
Total Aeronautics Research Net Cost	715	693
Exploration Systems		
Intragovernmental Costs	228	220
Public Cost	4,925	4,591
Total Exploration Systems Costs	5,153	4,811
Intragovernmental Earned Revenue	19	12
Public Earned Revenue	14	16
Total Exploration Systems Earned Revenue	33	28
Total Exploration Systems Net Cost	5,120	4,783
Science		
Intragovernmental Costs	395	369
Public Cost	6,211	6,023
Total Science Costs	6,606	6,392
Intragovernmental Earned Revenue	595	494
Public Earned Revenue	21	17
Total Science Earned Revenue	616	511
Total Science Net Cost	5,990	5,881
Space Operations		
Intragovernmental Costs	471	458
Public Cost	10,599	6,991
Total Space Operations Costs	11,070	7,449
Intragovernmental Earned Revenue	349	320
Public Earned Revenue	79	98
Total Space Operations Earned Revenue	428	418
Total Space Operations Net Cost	10,642	7,031
Net Cost of Operations	\$ 22,467	\$ 18,388

National Aeronautics and Space Administration
Notes to Financial Statements
(Fiscal Years 2009 and 2008 are Unaudited)

NOTE 14. APPORTIONMENT CATEGORIES OF OBLIGATIONS INCURRED: DIRECT VS. REIMBURSABLE OBLIGATIONS

Category A consists of amounts requested to be apportioned for each calendar quarter in the fiscal year. Category B consists of amounts requested to be apportioned on a basis other than calendar quarters, such as time periods other than quarters, activities, projects, objects, or a combination thereof.

(In Millions of Dollars)	2009	2008
Direct Obligations:		
Category A	\$ 1	\$ 1
Category B	18,701	19,176
Reimbursable Obligations:		
Category B	<u>1,475</u>	<u>1,122</u>
Total Obligations Incurred	<u><u>\$ 20,177</u></u>	<u><u>\$ 20,299</u></u>

NOTE 15. EXPLANATION OF DIFFERENCES BETWEEN THE STATEMENT OF BUDGETARY RESOURCES (SBR) AND THE BUDGET OF THE U.S. GOVERNMENT

The *FY 2011 Budget of the United States Government* (President's Budget) presenting the actual amounts for the year ended September 30, 2009 has not been published as of the issue date of these financial statements. The FY 2011 President's Budget is scheduled for publication in 2010.

NASA reconciled the amounts of the FY 2008 column on the Statement of Budgetary Resources (SBR) to the actual amounts for FY 2008 in the FY 2010 President's Budget for budgetary resources, obligations incurred, distributed offsetting receipts and net outlays as presented below.

(In Millions of Dollars)	Budgetary Resources	Obligations Incurred	Distributed Offsetting Receipts	Net Outlays
Combined Statement of Budgetary Resources	\$ 21,293	\$ 20,299	\$ (1)	\$ 17,840
Included on SBR, not in President's Budget				
Expired Accounts	(317)	(139)	—	—
Distributed Offsetting Receipts	—	—	1	—
Other	—	(1)	—	(3)
Budget of the United States Government	<u><u>\$ 20,976</u></u>	<u><u>\$ 20,159</u></u>	<u><u>\$ —</u></u>	<u><u>\$ 17,837</u></u>

The difference between the Statement of Budgetary Resources and the President's Budget represents expired, unobligated balances reported on the SBR but not in the *Budget of the United States Government* and other is primarily rounding.

NOTE 16. UNDELIVERED ORDERS AT THE END OF THE PERIOD

Undelivered Orders at the end of the period totaled \$5,798 million and \$6,188 million as of September 30, 2009 and September 30, 2008, respectively.

National Aeronautics and Space Administration
Notes to Financial Statements
(Fiscal Years 2009 and 2008 are Unaudited)

NOTE 17. RESTATEMENT

In preparation for the release of SFFAS 35, *Estimating the Historical Cost of General Property, Plant, and Equipment -- Amending Statements of Federal Financial Accounting Standards 6 and 23* NASA performed an analysis of the methodology used to account for the historical costs of the International Space Station (ISS) the Space Shuttle and Work in Process (WIP). Based on that analysis, adjustments were recorded to ISS and WIP to reflect their estimated cost.

This analysis resulted in a decrease to the beginning balance of Cumulative Results of Operations on the Statement of Changes in Net Position of \$6.6 billion.

National Aeronautics and Space Administration
Notes to Financial Statements
(Fiscal Years 2009 and 2008 are Unaudited)

NOTE 18. RECONCILIATION OF NET COST TO BUDGET

Statement of Federal Financial Accounting Standards No. 7 (SFFAS 7), *Accounting for Revenues and Other Financing Sources and Concepts for Reconciling Budgetary and Financial Accounting* requires a reconciliation of proprietary and budgetary accounting information. Accrual-based measures used in the Statement of Net Cost differ from the obligation-based measures used in the Statement of Budgetary Resources.

The Statement of Financing is intended to provide assurance certain financial information is consistent with similar amounts found in budget reports. This note reconciles obligations of budget authority to the accrual-based net cost of operations. The Net Cost of Operations as presented on the Statement of Financing is determined by netting the obligations as adjusted and non-budgetary resources and making adjustments for the total resources that do not fund net cost of operations, the total costs that do not require resources, and financing sources yet to be provided. The result is Net Cost of Operations as reported on the Statement of Net Cost.

(In Millions of Dollars)	2009	2008
Resources Used to Finance Activities		
Budgetary Resources Obligated		
Obligations Incurred	\$ 20,177	\$ 20,299
Less: Spending Authority from Offsetting Collections and Recoveries	1,766	1,539
Obligations Net of Offsetting Collections and Recoveries	<u>18,411</u>	<u>18,760</u>
Less: Offsetting Receipts	1	(1)
Net Obligations	<u>18,410</u>	<u>18,761</u>
Other Resources		
Donations & Forfeitures of Property	10	—
Transfers In/Out Without Reimbursements	57	2
Imputed Financing from Costs Absorbed by Others	<u>151</u>	<u>143</u>
Net Other Resources Used to Finance Activities	<u>218</u>	<u>145</u>
Total Resources Used to Finance Activities	<u>18,628</u>	<u>18,906</u>
Resources Used to Finance Items Not Part of the Net Cost of Operations		
Change in Budgetary Resources Obligated for Goods, Services, and Benefits Ordered But Not Yet Provided	583	(584)
Resources That Fund Expenses Recognized in Prior Periods	(71)	(29)
Resources that Finance the Acquisition of Assets	(3,023)	(5,868)
Other Resources or Adjustments to Net Obligated Resources That Do Not Affect Net Cost of Operations	<u>(67)</u>	<u>(2)</u>
Total Resources Used to Finance Items Not Part of the Net Cost of Operations	<u>(2,578)</u>	<u>(6,483)</u>
Total Resources Used to Finance the Net Cost of Operations	<u>\$ 16,050</u>	<u>\$ 12,423</u>

National Aeronautics and Space Administration
Notes to Financial Statements
(Fiscal Years 2009 and 2008 Are Unaudited)

NOTE 18. RECONCILIATION OF NET COST TO BUDGET (CONTINUED)

(In Millions of Dollars)	2009	2008
Components of Net Cost That Will Not Require or Generate Resources in the Current Period		
Components Requiring or Generating Resources in Future Periods		
Increases in Annual Leave Liability	\$ 12	\$ 14
Other	—	5
	<hr/>	<hr/>
Total Components of Net Cost that Will Require or Generate Resources in Future Periods	12	19
	<hr/>	<hr/>
Components Not Requiring or Generating Resources		
Depreciation	2,511	2,405
Revaluation of Assets or Liabilities	(62)	6
Other	3,956	3,535
	<hr/>	<hr/>
Total Components of Net Cost of Operations that Will Not Require or Generate Resources	6,405	5,946
	<hr/>	<hr/>
Total Components of Net Cost of Operations that Will Not Require or Generate Resources in the Current Period	6,417	5,965
	<hr/>	<hr/>
Net Cost of Operations	\$ 22,467	\$ 18,388
	<hr/>	<hr/>

**National Aeronautics and Space Administration
Required Supplementary Stewardship Information
(Fiscal Years 2009, 2008, 2007, and 2006 Are Unaudited)
Stewardship Investments: Research and Development**

Research and Development Expenses by Business Lines

NASA's programs and activities are carried out through four Business Lines: Aeronautics Research, Exploration Systems, Science and Space Operations. Each Business Line is comprised of multiple themes and numerous programs comprise each theme. In FY 2006 NASA's former enterprise structure was mapped to the new Business Line structure and NASA reports Research and Development (R&D) expenses using the new structure. Therefore, R&D expenses are now reported on a program not Enterprise basis. This is NASA's fourth year reporting under this new structure.

To provide the reader with a full picture of NASA expenses, both R&D and non-R&D, NASA has included expenses for non R&D costs associated with NASA activities such as Education and Outreach, Space Operations Programs. Descriptions for the work associated with these costs are also presented.

**National Aeronautics and Space Administration
Required Supplementary Stewardship Information
(Fiscal Years 2009, 2008, 2007, and 2006 Are Unaudited)
Stewardship Investments: Research and Development**

Research and Development Expenses by Business Line by Theme by Program

(In Millions of Dollars)	2009	2008	2007	2006
Aeronautics Research				
Aeronautics Technology				
Aviation Safety	\$ 79	\$ 81	\$ 64	\$ 152
Airspace Systems	124	108	87	144
Fundamental Aeronautics	442	438	405	754
Aeronautics Test	70	66	38	—
Aeronautics Technology Total	<u>715</u>	<u>693</u>	<u>594</u>	<u>1,050</u>
Aeronautics Research Total	<u>\$ 715</u>	<u>\$ 693</u>	<u>\$ 594</u>	<u>\$ 1,050</u>
Exploration Systems				
Constellation Systems				
Constellation Systems	<u>\$ 4,539</u>	<u>\$ 4,093</u>	<u>\$ 2,385</u>	<u>\$ 1,419</u>
Constellation Systems Total	<u>4,539</u>	<u>4,093</u>	<u>2,385</u>	<u>1,419</u>
Exploration Systems Research & Technology				
Exploration Technology Development	304	267	306	—
Lunar Precursor Robotic Program	94	124	149	95
Prometheus Nuclear Systems & Technology	2	3	14	—
Nuclear Flight Systems	—	11	—	24
Advanced Systems and Technology	—	—	—	291
Advance Space Technology	11	38	—	3
Technology Maturation	—	12	—	111
Exploration Systems Research & Technology Total	<u>411</u>	<u>455</u>	<u>469</u>	<u>524</u>
Human Systems Research & Technology				
Life Support & Habitation	6	59	130	361
Human Health & Performance	7	90	160	136
Human Research Program	157	80	—	—
Human Systems Integration	—	6	44	174
Human Systems Research & Technology Total	<u>170</u>	<u>235</u>	<u>334</u>	<u>671</u>
Exploration Systems Total	<u>\$ 5,120</u>	<u>\$ 4,783</u>	<u>\$ 3,188</u>	<u>\$ 2,614</u>

**National Aeronautics and Space Administration
Required Supplementary Stewardship Information
(Fiscal Years 2009, 2008, 2007, and 2006 Are Unaudited)
Stewardship Investments: Research and Development**

Research and Development Expenses by Business Line by Theme by Program (Continued)

(In Millions of Dollars)	2009	2008	2007	2006
Science				
Planetary Science				
Discovery	\$ —	\$ 72	\$ 129	\$ 127
New Frontiers	296	97	107	107
Technology	1,695	1,413	941	1,277
Deep Space Mission Systems (DSMS)	71	228	221	187
New Millennium	8	3	—	—
Planetary Science Research	—	—	255	321
Mars Exploration	409	779	699	599
Planetary Science Total	2,479	2,592	2,352	2,618
Astrophysics				
Navigator	73	56	88	87
James Webb Space Telescope	63	407	324	315
Hubble Space Telescope	42	216	135	452
SOFIA	21	63	51	—
Gamma-ray Large Space Telescope (GLAST)	15	60	70	87
Discovery	230	114	110	114
Astrophysics Explorer	118	85	69	58
Astrophysics Research	247	258	226	225
Cosmic Origins	584	—	—	—
Physics of the Cosmos	87	—	—	—
Heliophysics Explorer	38	56	—	—
Heliophysics Research	158	77	—	—
International Space Science Collaboration	10	18	15	6
Beyond Einstein	8	15	12	8
Astrophysics Total	1,694	1,425	1,100	1,352
Earth–Sun System				
Earth Systematic Missions	514	341	201	293
Living with a Star	179	153	163	257
Solar Terrestrial Probes	89	60	47	95
Explorer	—	—	78	114
Earth System Science Pathfinder	98	121	119	104
Earth–Sun System Multi-Mission Operations	139	167	209	290
Earth–Sun System Division	10	622	718	926
Near Earth Networks	9	47	—	—
Earth Science Research	423	—	—	—
Planetary Science Research	238	277	—	—
Applied Sciences	47	53	60	48
Earth–Sun Technology	57	—	85	82
Earth–Sun System	1,803	1,841	1,680	2,209
Science Total	\$ 5,976	\$ 5,858	\$ 5,132	\$ 6,179
Total Research & Development Expenses	\$ 11,811	\$ 11,334	\$ 8,914	\$ 9,843

**National Aeronautics and Space Administration
Required Supplementary Stewardship Information
(Fiscal Years 2009, 2008, 2007, and 2006 Are Unaudited)
Stewardship Investments: Research and Development**

Non-Research and Development Expenses by Business Line by Theme by Program

(In Millions of Dollars)	2009	2008	2007	2006
Science				
Astrophysics				
SOFIA	\$ —	\$ —	\$ —	\$ 58
Earth–Sun System				
Education and Outreach	14	23	22	40
Science Total	\$ 14	\$ 23	\$ 22	\$ 98
Space Operations				
Space Shuttle				
Space Shuttle	\$ 3,285	\$ 3,306	\$ 3,351	\$ 4,245
Hurricane Recovery	—	94	85	—
Subtotal Space Shuttle	3,285	3,400	3,436	4,245
International Space Station	2,166	1,588	1,402	1,705
Space and Flight Support (SFS)				
Space Communications	547	210	152	—
Launch Services	4,589	1,780	1,102	—
Rocket Propulsion Testing	46	44	43	—
Crew Health & Safety	9	9	7	—
Space and Flight Support	—	—	—	1,743
Subtotal Space and Flight Support (SFS)	5,191	2,043	1,304	1,743
Space Operations Total	\$ 10,642	\$ 7,031	\$ 6,142	\$ 7,693
Total Non-Research & Development Expenses	\$ 10,656	\$ 7,054	\$ 6,164	\$ 7,791
Total Expenses	\$ 22,467	\$ 18,388	\$ 15,078	\$ 17,634

**National Aeronautics and Space Administration
Required Supplementary Stewardship Information
(Fiscal Years 2009, 2008, 2007, and 2006 Are Unaudited)
Stewardship Investments: Research and Development**

NASA makes substantial research and development investments for the benefit of the United States. These amounts are expensed as incurred in determining the net cost of operations.

NASA's research and development programs include activities to extend our knowledge of Earth, its space environment, and the universe, and to invest in new aeronautics and advanced space transportation technologies that support the development and application of technologies critical to the economic, scientific, and technical competitiveness of the United States.

Investment in research and development refers to those expenses incurred to support the search for new or refined knowledge and ideas and for the application or use of such knowledge and ideas for the development of new or improved products and processes with the expectation of maintaining or increasing national economic productive capacity or yielding other future benefits. Research and development is composed of the following:

Basic Research: Systematic study to gain knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications toward processes or products in mind;

Applied Research: Systematic study to gain knowledge or understanding necessary for determining the means by which a recognized and specific need may be met; and

Development: Systematic use of the knowledge and understanding gained from research for the production of useful materials, devices, systems or methods, including the design and development of prototypes and processes.

Business Line Theme and Program Descriptions

BUSINESS LINE: AERONAUTICS

Theme: Aeronautics Technology (AT)

Aeronautics Technology develops technologies to improve aircraft and air system safety, security and performance; reduce aircraft noise and emissions; and increase the capacity of the National Airspace System (NAS).

Program: Aviation Safety (AvSP)

The Aviation Safety Program (AvSP) develops innovative tools, concepts, methods, and technologies that will improve the intrinsic safety attributes of current and future aircraft, and that will help overcome aviation safety challenges that would otherwise constrain the full realization of the Next Generation Air Transportation System (NextGen).

Program: Airspace Systems Program (ASP)

The Airspace Systems Program conducts research to enable NextGen capabilities such as foundational research in multi-aircraft flow and airspace optimization, trajectory design and conformance, separation methods, and adaptive systems. The Program research for the airspace and airportal domains is integrated into gate-to-gate solutions.

Program: Fundamental Aeronautics

The Fundamental Aeronautics Program (FAP) conducts research to enable the design of vehicles that fly through any atmosphere at any speed. Future aircraft must address multiple design challenges, and therefore a key focus will be the development of physics-based, multidisciplinary design, analysis, and optimization (MDAO) tools.

Program: Aeronautics Test Program

The Aeronautics Test Program (ATP) is dedicated to the mastery and intellectual stewardship of the core competencies of Aeronautics testing, both on the ground and in the air. ATP's purpose is to ensure the strategic availability of a minimum, critical suite of aeronautical test facilities which are necessary to meet the long-term needs and requirements of the nation.

**National Aeronautics and Space Administration
Required Supplementary Stewardship Information
(Fiscal Years 2009, 2008, 2007, and 2006 Are Unaudited)
Stewardship Investments: Research and Development**

BUSINESS LINE: EXPLORATION SYSTEMS

Theme: Constellation Systems

Through the Constellation Systems Theme NASA will develop, demonstrate, and deploy the collection of systems that will enable sustained human and robotic exploration of the Moon, Mars, and beyond.

Program: Constellation Systems

The Constellation Systems program (which replaced the Earth Orbit Capability program) objective is to develop, demonstrate, and deploy the capabilities to transport crew and cargo for missions to the lunar surface safely return the crew to Earth.

Theme: Advanced Capabilities

The Advanced Capabilities Theme provides knowledge, technology, and innovation that will enable current and future exploration missions.

Program: Exploration Technology Development

The Exploration Technology Development Program (ETDP) develops new technologies that will enable NASA to conduct future human and robotic exploration missions, while reducing mission risk and cost. By maturing new technologies to the level of demonstration in a relevant environment early enough to support a flight system's Preliminary Design Review, NASA can significantly reduce both cost and risk.

Program: Lunar Precursor Robotic

The Lunar Precursor Robotic program supports America's return to the Moon by executing lunar robotic missions to conduct research and prepare for future human exploration. These missions will gather data important for reducing the risks to astronauts, identify resources, and map the lunar environment.

Program: Human Research

The Human Research program (HRP) investigates and mitigates the highest risks to human health and performance in support of NASA exploration missions. ESMD and Constellation Systems documents provide the mission architecture definitions, mission concepts of operations, vehicle, habitat, and space suit performance requirements, and other technical information needed to focus the HRP efforts for specific exploration missions. HRP conducts research, develops countermeasures, and undertakes technology development to inform and support compliance with NASA's health, medical, human performance, and environmental standards.

BUSINESS LINE: SCIENCE

Theme: Planetary Science

The Planetary Science Theme advances scientific knowledge of the origin and history of the solar system, including the history of life and whether it evolved beyond Earth. Equally important is finding resources, evaluating, and mitigating the risks to humans that will be encountered as we conduct an overall balanced program of science, exploration, and aeronautics consistent with the redirection of the human spaceflight program to focus on exploration.

Program: Discovery

NASA's Discovery program gives scientists the opportunity to find innovative ways to unlock the mysteries of the solar system. It provides lower-cost, highly focused planetary science investigations designed to enhance our understanding of the solar system. The Discovery program offers the scientific community the opportunity to assemble a team and design exciting, focused science investigations that complement NASA's larger planetary science explorations.

**National Aeronautics and Space Administration
Required Supplementary Stewardship Information
(Fiscal Years 2009, 2008, 2007, and 2006 Are Unaudited)
Stewardship Investments: Research and Development**

Program: New Frontiers

The New Frontiers program, a class of competed medium-sized missions, represents a critical step in the advancement of the solar system exploration. Proposed science targets for the New Frontiers program include Pluto and the Kuiper Belt, Jupiter, Venus, and sample returns from Earth's Moon and a comet nucleus.

Program: Technology

Robotic spacecraft use electrical power for propulsion, data acquisition, and communication to accurately place themselves in orbit around and onto the surfaces of bodies about which we may know relatively little. These systems ensure that they survive and function in hostile and unknown environments, acquire and transmit data throughout their lifetimes, and sometimes transport samples back to Earth. Since successful completion of these missions is so dependent on power, the future Planetary Science program portfolio of missions will demand advances in power and propulsion systems.

Program: Planetary Science Research

The Planetary Science Research program develops the theoretical tools and laboratory data needed to analyze flight data, makes possible new and better instruments to fly on future missions, and analyzes the data returned so that the program can answer specific questions posed and fit this new knowledge into the overall picture of the solar system.

Program: Mars Exploration

The Mars Exploration program has been developed to conduct a rigorous, incremental, discovery-driven exploration of Mars to determine the planet's physical, dynamic, and geological characteristics, investigate the Martian climate in the context of understanding habitability, and investigate whether Mars ever had the potential to develop and harbor any kind of life.

Theme: Astrophysics

The Astrophysics Theme seeks to understand the cycles of matter and energy that formed, evolve, and govern the universe, and how they created the unique conditions that support life. Where are we from? Are we alone? NASA searches for answers to these questions looking far away, towards the beginning of time, to see galaxies forming, and close to home, in search of planetary systems like Earth around nearby stars.

Program: Navigator

The Navigator program consists of a coherent series of increasingly challenging projects, each complementary to the others and each mission building on the results and capabilities of those that preceded it as NASA searches for habitable planets outside of the solar system.

Program: The James Webb Space Telescope (JWST)

The program identified by the National Research Council as the top priority for astronomy and physics for the current decade--is a large, deployable infrared astronomical space-based observatory. The mission is a logical successor to the HST, extending beyond Hubble's discoveries into the infrared, where the highly redshifted early universe must be observed, where cool objects like protostars and protoplanetary disks emit strongly, and where dust obscures shorter wavelengths.

Program: Hubble Space Telescope

Since 1990, the HST has used its pointing precision, powerful optics, and state-of-the-art instruments to explore the visible, ultraviolet and near-infrared regions of the electromagnetic spectrum. Until such time that Hubble is no longer able to carry out its scientific mission, the observatory will continue to investigate the formation, structure, and evolution of stars and galaxies, studying the history of the universe, and providing a space-based research facility for optical astronomy. Hubble development funding supports a suite of life extension activities, which will maximize science return as the telescope's capabilities degrade over time. In addition, a robotic spacecraft is under development to be launched on an expendable launch vehicle, rendezvous with HST, and safely deorbit the observatory at the end of its useful science life. While this development activity is underway, modification and upkeep of ground operations systems will continue.

**National Aeronautics and Space Administration
Required Supplementary Stewardship Information
(Fiscal Years 2009, 2008, 2007, and 2006 Are Unaudited)
Stewardship Investments: Research and Development**

Program: SOFIA

The Stratospheric Observatory for Infrared Astronomy (SOFIA) program offers a unique world-class facility for infrared astronomy covering parts of the spectrum that cannot be covered from the ground. As a result, SOFIA will provide unique insights into scientific questions regarding energetics of luminous galaxies, the origin of stars and planetary systems, gas and grain chemistry of the interstellar medium, and the structure of the solar system.

Program: Gamma-ray Large Area Space Telescope (GLAST)

A collaboration with the Department of Energy, France, Italy, Sweden, Japan, and Germany, the Gamma-ray Large Area Space Telescope (GLAST) will improve researchers' understanding of the structure of the universe, from its earliest beginnings to its ultimate fate. By measuring the direction, energy, and arrival time of celestial high-energy gamma rays, GLAST will map the sky with 50 times the sensitivity of previous missions, with corresponding improvements in resolution and coverage. Yielding new insights into the sources of high-energy cosmic gamma rays, GLAST will reveal the nature of astrophysical jets and relativistic flows and study the sources of gamma-ray bursts.

Program: Discovery

The Discovery program gives scientists the opportunity to dig deep into their imaginations and find innovative ways to unlock the mysteries of the solar system. Discovery is an ongoing program that offers the scientific community the opportunity to assemble a team and design exciting, focused science investigations that complement NASA's larger planetary science explorations.

Program: Astrophysics Explorer

The Astrophysics Explorer program (formerly Explorer) provides frequent flight opportunities for world-class astrophysics and space physics investigations, utilizing innovative, streamlined and efficient management approaches to spacecraft development and operations. The program (including Future Explorers) is managed within the Earth -Sun Theme, but selected projects are managed under the Universe Theme.

Program: Astrophysics Research

The Astrophysics Research program (formerly Universe Research) strives to answer critical questions about the nature of the universe with a host of operating missions led by investigators from academia and industry, as well as funding grants for basic research, technology development, and data analysis from past and current missions. All data collected by missions are archived in data centers located at universities and NASA centers throughout the country.

Program: Cosmic Origins

Discover how the universe developed over cosmic time from the big bang to its modern configuration of galaxies, stars and planets. The focus is to explore how the expanding universe grew into a grand, cosmic web of galaxies; how within the galaxies stars and planets formed; and how stars create the heavy elements such as carbon, oxygen, and iron that are essential for life.

Program: Physics of the Cosmos

Reveal laws and forces of the universe at the most fundamental level in ways that can only be done from space. Missions will probe back to the beginning of time by measuring the cosmic microwave background radiation in novel ways and using gravity waves as an entirely new window on the universe. The nature of dark matter that shepherds the growth of galaxies and large-scale structure will be determined, the mysterious dark energy pervading the universe will be uncovered and the limits of Einstein's theories will be tested.

Program: International Space Science Collaboration (SSC)

Herschel and Planck, two projects in the International Space Science Collaboration (SSC) Program, are European Space Agency (ESA)-led missions. Herschel has been designed to unveil a face of the early universe that has remained hidden until now. Planck will help provide answers to one of the most important sets of questions asked in modern science: how did the universe begin, how did it evolve to the state we observe today, and how will it continue to evolve in the future?

National Aeronautics and Space Administration
Required Supplementary Stewardship Information
(Fiscal Years 2009, 2008, 2007, and 2006 Are Unaudited)
Stewardship Investments: Research and Development

Program: Beyond Einstein

Beyond Einstein missions seek to explain the phenomena associated with Albert Einstein's theory of general relativity, and thereby better understand the phenomena that govern the universe. To find answers, scientists must move beyond Einstein's theory; they must employ new techniques and launch missions to observe the universe in new and advanced ways. They must test and validate these new theories and enjoin heretofore separate fields like astronomy and particle physics.

Theme: Earth Science

NASA studies this dynamic Earth system to trace effect to cause, connect variability and forcing with response, and vastly improve national capabilities to predict climate, weather, natural hazards, and conditions in the space environment.

Program: Earth Science Research

The Earth Science Research Program improves the capability to document the global distribution of a range of important environmental parameters related to the Earth's atmosphere, hydrosphere, biosphere, cryosphere, and land surface; to understand the processes that drive and connect them; and to improve our capability to predict the future evolution of the Earth system, including climate, weather, and natural hazards.

Program: Applied Sciences

The Applied Sciences Program is focused on working with Federal agencies and national organizations to extend the use of technology and data associated with NASA's constellation of Earth system observing spacecraft. These spacecraft, which routinely make measurements using dozens of research instruments, are used by a community of Earth system scientists in laboratories, universities, and research institutions throughout the country, and around the world, to model the Earth system and improve predictions, projections, and forecasts.

Program: Earth Science System Multi-Mission Operations

The Earth Science Multi-Mission Operations Program acquires, preserves, and distributes observational data to support Earth Science focus areas in conformance with national science objectives. Facilities involved in this undertaking include data-handling, data processing, and archiving systems.

Program: Earth Systematic Missions

Earth Systematic Missions provide Earth observing satellites that contribute to the provision of long-term environmental data sets that can be used to study the evolution of the Earth system on a range of temporal scales. This information is used to analyze, model, and improve understanding of the Earth system.

Program: Earth System Science Pathfinder (ESSP)

This program addresses unique, specific, highly-focused mission requirements in Earth science research. ESSP includes a series of relatively low to moderate cost, small to medium sized, competitively selected, principal investigator led missions that are built, tested, and launched in a short time interval. These missions are capable of supporting a variety of scientific objectives related to Earth science, involving the atmosphere, oceans, land surface, polar ice regions and solid earth.

Program: Earth Science Technology

The Earth Science Technology Program (ESTP) provides the Earth Science Theme with new capabilities, enabling previously unforeseen or infeasible science investigations, enhancing existing measurement capabilities, and reducing the cost, risk, and development times of Earth science measurements.

Theme: Heliophysics

The Heliophysics Theme studies the science of the Sun-Solar System Connection to: (1) understand the Sun and its effects on Earth, the solar system, and the space environmental conditions that will be experienced by explorers, and (2) demonstrate technologies that can improve future operational systems.

Program: Heliophysics Research

The Heliophysics Research program undertakes scientific investigations utilizing operational spacebased and suborbital platforms (surface, balloon, aircraft, and rocket). The program also funds basic research and modeling utilizing the results of the full array of NASA's missions.

Program: Deep Space Mission Systems (DSMS)

The Deep Space Mission System (DSMS) program enables human and robotic exploration of the solar system and beyond by providing reliable, high-performance, and cost-effective telecommunications and navigation services.

Program: Living with a Star

The Living with a Star (LWS) program seeks to understand how and why the Sun varies, how Earth and other planets respond, and how the variability and response affect humanity. Achieving these goals will enable a reliable space weather prediction so undesirable space weather effects can be accommodated or mitigated before they occur.

Program: Solar Terrestrial Probes (STP)

The primary goal of the Solar Terrestrial Probes (STP) Program is to understand how the Sun, heliosphere, and planetary environments are connected in a single system.

Program: Heliophysics Explorer

The Heliophysics Explorer program provides frequent flight opportunities for world-class astrophysics and space physics investigations, using innovative, streamlined and efficient management approaches to spacecraft development and operations. The program is composed of an on-going series of space science missions that are independent, but share a common funding and management structure. The program emphasizes missions that can be accomplished under the control of the scientific research community and seeks to control total mission life-cycle costs. It also seeks to enhance public awareness of, and appreciation for, space science and to incorporate educational and public outreach activities.

Program: Near Earth Networks

The Near Earth Networks program provides multi-mission driven space flight tracking, telemetry and command, meteorological and photo-optical services and associated activities of customer interface, network and range scheduling, cross-cutting maintenance and systems engineering, facilities, safety, and security. These services are for near-Earth spaceflight missions, including human space flight (Space Shuttle Program and Constellation), sounding rockets, and near-Earth orbital flight in support of Science missions, Space Operations, Exploration Systems, and aeronautics services for unmanned aerial vehicle, aircraft, and rockets in support of upper atmospheric research.

Program: New Millennium

The New Millennium Program (NMP) is a technology flight validation program designed to retire risk of key emerging and breakthrough technologies to enable future NASA science missions. The objectives are to capitalize on investments being made in U.S. technological capabilities and accelerate the incorporation of payoff, advanced technologies into future science missions by conducting in-space validation missions, when the technologies must be tested in space in order to be validated. NMP allows NASA to conduct technology maturation and validation in low-cost NMP projects, rather than during science mission development.

NON-R&D Programs

BUSINESS LINE: SCIENCE

Theme: Earth Science

Program: Education and Outreach

The Earth Science Education and Outreach Program seeks to make the discoveries and knowledge generated from NASA's Earth-observing satellites and scientific research (including applied science) accessible to students, teachers, and the public. It addresses workforce preparation and the education pipeline, and engages the public in better understanding NASA Earth Science research results from space.

BUSINESS LINE: SPACE OPERATIONS

Theme: Space Shuttle

The Space Shuttle is currently the only launch capability owned by the United States that enables human access to space, and the only vehicle that can support the assembly of the International Space Station (ISS). NASA will phase-out the Space Shuttle in 2010 when its role in ISS assembly is complete.

Program: Space Shuttle

In FY 2008, the Space Shuttle Program completed four ISS assembly flights, which included the launch of major research facility modules from the European Space Agency and Japan. In FY 2009, the Space Shuttle Program manifest calls for completing the SM4 servicing mission to the Hubble Space Telescope.

Program: Hurricane Recovery

The Hurricane Recovery program includes emergency supplemental costs for Hurricane Katrina response and recovery.

Theme: International Space Station

This Theme supports the construction and operations of a research facility in low Earth orbit as NASA's first step in achieving the Vision for Space Exploration. The ISS provides a unique, continuously operating capability to develop medical countermeasures for long-term human space travel; develop and test technologies and engineering solutions in support of exploration; and provide ongoing practical experience in living and working in space. It also supports a variety of pure and applied research for the U.S. and its International Partners. ISS assembly will be completed by the end of the decade. NASA is examining configurations for the Space Station that meet the needs of both the new space exploration vision and our international partners using as few Shuttle flights as possible. A key element of the ISS program is the crew and cargo services project, which will purchase services for cargo and crew transport using existing and emerging capabilities.

Theme: Space and Flight Support

This theme encompasses Space Communications, Launch Services, Rocket Propulsion Testing, and Crew Health and Safety. Space Communications consists of (1) the Tracking and Data Relay Satellite System (TDRSS), which supports activities such as the Space Shuttle, ISS, Expendable Launch Vehicles, and research aircraft, and (2) the NASA Integrated Services Network, which provides telecommunications services at facilities, such as flight support networks, mission control centers and science facilities, and administrative communications networks for NASA Centers. The Launch Services program focuses on meeting the Agency's launch and payload processing requirements by assuring safe and cost-effective access to space via the Space Shuttle and expendable launch vehicles.

Program: Space Communications

The Space Communications Program (SCP) links flight missions to Earth to accomplish mission objectives. NASA's backbone of communications capabilities reliably transmits data between the ground control centers and the flight missions. These capabilities keep the missions operating safely and return volumes of science and technology data that has led to innumerable discoveries about Earth, the solar system, and the universe.

Program: Launch Services

The Launch Services Program, which works closely with other government agencies and the launch industry, seeks to ensure that the most safe, reliable, on-time, cost-effective launch opportunities are available on a wide range of launch systems.

Program: Rocket Propulsion Testing

As the principal implementing authority for NASA's rocket propulsion testing, the Rocket Propulsion Test (RPT) Program reviews, approves, and provides direction on rocket propulsion test assignments, capital asset improvements, test facility modernizations and refurbishments, integration for multi-site test activities, identification and protection of core capabilities, and the advancement and development of test technologies.

Program: Crew Health & Safety

The health care of the NASA Astronaut Corps is the responsibility of space medical operations at the Johnson Space Center. A portion of the responsibilities for that care is managed within the Crew Health and Safety program (CHS). CHS enables the following: 1) healthy and productive crew during all phases of spaceflight missions; 2) implementation of a comprehensive health care program for astronauts; and 3) the prevention and mitigation of negative long-term health consequences of space flight.

**National Aeronautics and Space Administration
 Required Supplementary Information
 Combined Schedule of Budgetary Resources
 (For the Fiscal Year Ended September 30, 2009, Unaudited)**

(In Millions of Dollars)	Space Operations	Science Mission	Exploration Mission	Aeronautics Mission	Cross-Agency Mission	Education Mission	Office of Inspector General	American Recovery and Reinvestment Act	Exploration, Science, and Aeronautics	Other	Total
Budgetary Resources											
Unobligated Balance, Brought Forward, October 1	\$ 245	\$ —	\$ —	\$ —	\$ —	\$ —	\$ 3	\$ —	\$ 694	\$ 52	\$ 994
Recoveries of Prior Year Obligations	101	—	—	—	—	—	—	—	191	36	328
Budget Authority:											
Appropriation	5,765	4,503	3,506	500	3,306	169	34	1,002	—	1	18,786
Spending Authority from Offsetting Collections Earned											
Collected	162	—	—	—	466	—	—	—	400	77	1,105
Change in Receivable from Federal Sources	(27)	—	—	—	190	—	—	1	(23)	—	141
Change in Unfilled Orders											
Advance Received	(47)	—	—	—	137	—	—	—	(64)	1	27
Without Advance from Federal Sources	(96)	—	—	—	567	—	—	46	(337)	(15)	165
Subtotal	5,757	4,503	3,506	500	4,666	169	34	1,049	(24)	64	20,224
Nonexpenditure Transfers, Net:											
Actual Transfers, Budget Authority	—	—	—	—	—	—	—	—	—	—	—
Actual Transfers, Unobligated Balances	—	—	—	—	—	—	—	—	—	—	—
Permanently Not Available											
Cancellations of Expired and No-year Accounts	—	—	—	—	—	—	(1)	—	—	(48)	(49)
Enacted Reductions	—	—	—	—	—	—	—	—	—	—	—
Total Budgetary Resources	\$ 6,103	\$ 4,503	\$ 3,506	\$ 500	\$ 4,666	\$ 169	\$ 36	\$ 1,049	\$ 861	\$ 104	\$ 21,497
Status of Budgetary Resources											
Obligations Incurred:											
Direct:	\$ 5,969	\$ 4,441	\$ 3,459	\$ 496	\$ 3,245	\$ 141	\$ 33	\$ 393	\$ 524	\$ 1	\$ 18,702
Reimbursable:	43	—	—	—	1,130	—	1	48	174	79	1,475
Subtotal	6,012	4,441	3,459	496	4,375	141	34	441	698	80	20,177
Unobligated Balance:											
Apportioned	43	62	47	4	291	28	—	608	31	16	1,130
Subtotal	43	62	47	4	291	28	—	608	31	16	1,130
Unobligated Balance Not Available	48	—	—	—	—	—	2	—	132	8	190
Total Status of Budgetary Resources	\$ 6,103	\$ 4,503	\$ 3,506	\$ 500	\$ 4,666	\$ 169	\$ 36	\$ 1,049	\$ 861	\$ 104	\$ 21,497
Change in Obligated Balance											
Obligated Balance, Net, October 1	\$ 2,236	\$ —	\$ —	\$ —	\$ —	\$ —	\$ 3	\$ —	\$ 5,975	\$ 85	\$ 8,299
Obligations Incurred	6,012	4,441	3,459	496	4,375	141	34	441	698	80	20,177
Less: Gross Outlays	6,836	2,199	2,350	286	2,738	24	32	38	5,714	92	20,309
Less: Recoveries of Prior Year Unpaid Obligations	101	—	—	—	—	—	—	—	191	36	328
Change in Uncollected Customer Payments from Federal Sources	122	—	—	—	(757)	—	—	(47)	360	16	(306)
	\$ 1,433	\$ 2,242	\$ 1,109	\$ 210	\$ 880	\$ 117	\$ 5	\$ 356	\$ 1,128	\$ 53	\$ 7,533
Obligated Balance, Net, End of Period	\$ 1,449	\$ 2,242	\$ 1,109	\$ 210	\$ 1,637	\$ 117	\$ 5	\$ 404	\$ 1,290	\$ 53	\$ 8,516
Unpaid Obligations	16	—	—	—	757	—	—	48	162	—	983
Less: Uncollected Customer Payments from Federal Sources	—	—	—	—	—	—	—	—	—	—	—
Total, Unpaid Obligated Balance, Net, End of Period	\$ 1,433	\$ 2,242	\$ 1,109	\$ 210	\$ 880	\$ 117	\$ 5	\$ 356	\$ 1,128	\$ 53	\$ 7,533
Outlays											
Net Outlays:											
Gross Outlays	\$ 6,836	\$ 2,199	\$ 2,350	\$ 286	\$ 2,738	\$ 24	\$ 32	\$ 38	\$ 5,714	\$ 96	\$ 20,313
Less: Offsetting Collections	115	—	—	—	603	—	—	—	336	82	1,136
Less: Distributed Offsetting Receipts	—	—	—	—	—	—	—	—	—	1	1
Net Outlays	\$ 6,721	\$ 2,199	\$ 2,350	\$ 286	\$ 2,135	\$ 24	\$ 32	\$ 38	\$ 5,378	\$ 13	\$ 19,176

**National Aeronautics and Space Administration
Required Supplementary Information
Combined Schedule of Budgetary Resources
(For the Fiscal Year Ended September 30, 2008, Unaudited)**

(In Millions of Dollars)	Exploration, Science, and Aeronautics	Space Operations	Office of Inspector General	Other	Total
<u>Budgetary Resources</u>					
Unobligated Balance, Brought Forward, October 1	\$ 1,847	\$ 648	\$ 4	\$ 95	\$ 2,594
Recoveries of Prior Year Obligations	331	170	—	47	548
Budget Authority:					
Appropriation	10,606	6,763	33	1	17,403
Spending Authority from Offsetting Collections					
Earned					
Collected	675	366	—	79	1,120
Change in Receivable from Federal Sources	(45)	(12)	—	(7)	(64)
Change in Unfilled Orders					
Advance Received	(2)	(3)	—	(2)	(7)
Without Advance from Federal Sources	52	(114)	—	4	(58)
Subtotal	<u>11,286</u>	<u>7,000</u>	<u>33</u>	<u>75</u>	<u>18,394</u>
Nonexpenditure Transfers, Net:					
Actual Transfers, Budget Authority	165	(165)	—	—	—
Actual Transfers, Unobligated Balances	5	8	—	(13)	—
Permanently Not Available					
Cancellations of Expired and No-year Accounts	—	—	(1)	(50)	(51)
Enacted Reductions	(166)	(25)	—	(1)	(192)
Total Budgetary Resources	<u>\$ 13,468</u>	<u>\$ 7,636</u>	<u>\$ 36</u>	<u>\$ 153</u>	<u>\$ 21,293</u>
<u>Status of Budgetary Resources</u>					
Obligations Incurred:					
Direct:	\$ 12,091	\$ 7,036	\$ 33	\$ 17	\$ 19,177
Reimbursable:	683	355	—	84	1,122
Subtotal	<u>12,774</u>	<u>7,391</u>	<u>33</u>	<u>101</u>	<u>20,299</u>
Unobligated Balance:					
Apportioned	587	182	—	17	786
Unobligated Balance Not Available	107	63	3	35	208
Total Status of Budgetary Resources	<u>\$ 13,468</u>	<u>\$ 7,636</u>	<u>\$ 36</u>	<u>\$ 153</u>	<u>\$ 21,293</u>
<u>Change in Obligated Balance</u>					
Obligated Balance, Net, October 1	\$ 5,494	\$ 1,725	\$ 5	\$ 154	\$ 7,378
Obligations Incurred	12,774	7,391	33	101	20,299
Less: Gross Outlays	11,956	6,836	34	126	18,952
Less: Recoveries of Prior Year Unpaid Obligations	331	170	—	47	548
Change in Uncollected Customer Payments from Federal Sources	(7)	126	—	3	122
	<u>\$ 5,974</u>	<u>\$ 2,236</u>	<u>\$ 4</u>	<u>\$ 85</u>	<u>\$ 8,299</u>
Obligated Balance, Net, End of Period					
Unpaid Obligations	\$ 6,497	\$ 2,374	\$ 4	\$ 100	\$ 8,975
Less: Uncollected Customer Payments from Federal Sources	523	138	—	15	676
Total, Unpaid Obligated Balance, Net, End of Period	<u>\$ 5,974</u>	<u>\$ 2,236</u>	<u>\$ 4</u>	<u>\$ 85</u>	<u>\$ 8,299</u>
<u>Outlays</u>					
Net Outlays:					
Gross Outlays	\$ 11,956	\$ 6,836	\$ 34	\$ 126	\$ 18,952
Less: Offsetting Collections	673	363	—	77	1,113
Less: Distributed Offsetting Receipts	—	—	—	(1)	(1)
Net Outlays	<u>\$ 11,283</u>	<u>\$ 6,473</u>	<u>\$ 34</u>	<u>\$ 50</u>	<u>\$ 17,840</u>

**National Aeronautics and Space Administration
 Required Supplementary Information
 (Fiscal Years 2009 and 2008 are Unaudited)
 Deferred Maintenance**

NASA uses a Deferred Maintenance parametric estimating method (DM method) in order to conduct a consistent condition assessment of its facilities. This method measures NASA’s current real property asset condition and to document real property deterioration. The DM method produces both a parametric cost estimate of deferred maintenance, and a Facility Condition Index (FCI). Both measures are indicators of the overall condition of NASA’s facility assets. The facilities condition assessment methodology involves an independent, rapid visual assessment of nine different systems within each facility to include: structure, roof, exterior, interior finishes, HVAC, electrical, plumbing, conveyance, and program support equipment. The DM method is designed for application to a large population of facilities; results are not necessarily applicable for individual facilities or small populations of facilities. Under this methodology, NASA defines acceptable operating conditions in accordance with standards comparable to those used in private industry, including the aerospace industry.

There has been no significant change in our deferred maintenance parametric estimating method this year. The Agency-wide FCI, based on the ratings obtained during the condition assessment site visits, remains unchanged from the previous fiscal year. The FCI values for the majority of individual Centers and sites varied less than 0.5, validating the relative stability of the Centers and sites despite the continued aging and deterioration of older facilities. Evaluation of the facility conditions by building type (Real Property Classification Code/DM Category) indicates that the Agency continues to focus maintenance and repair on direct mission-related facilities. Higher condition ratings are reported for potable water facilities, launch, communication and tracking, and fuel facilities Agency-wide. Lower condition ratings occur for infrastructure, site related systems, and static test stands.

(In Millions of Dollars)	2009	2008
Deferred Maintenance Method		
Facility Condition Index (FCI)	3.6	3.6
Target Facility Condition Index	3.8	3.8
Deferred Maintenance Estimate (Active and Inactive Facilities)	\$ 2,547	\$ 2,463



November 13, 2009

TO: Administrator
Chief Financial Officer

FROM: Acting Inspector General

SUBJECT: Audit of the National Aeronautics and Space Administration's
Fiscal Year 2009 Financial Statements (Report No. IG-10-002;
Assignment No. A-09-006-00)

Under the Chief Financial Officers Act of 1990, NASA's financial statements are to be audited in accordance with generally accepted government auditing standards. The Office of Inspector General contracted with the independent public accounting firm Ernst & Young LLP (E&Y) to audit NASA's financial statements in accordance with the Government Accountability Office's "Government Auditing Standards" and the Office of Management and Budget's Bulletin No. 07-04, "Audit Requirements for Federal Financial Statements," as amended.

In the "Report of Independent Auditors" (Enclosure 1), E&Y disclaimed an opinion on NASA's financial statements for the fiscal years ended September 30, 2009 and 2008. While the Agency made significant progress in improving its financial processes and systems, the disclaimer resulted from continued weaknesses in internal controls over accounting for legacy property, plant, and equipment (PP&E).

The E&Y "Report on Internal Control" (Enclosure 2) identifies three significant deficiencies, with one considered a material weakness. A material weakness was found in NASA's controls for assuring that property, plant, and equipment and materials are presented fairly in the financial statements. The two significant deficiencies involve NASA's (1) process for estimating environmental liabilities and (2) compliance with the Federal Financial Management Improvement Act of 1996 (FFMIA). E&Y's report contains specific recommendations that are intended to help the Agency in remediating all three deficiencies during FY 2010.

The E&Y "Report on Compliance with Laws and Regulations" (Enclosure 3) identifies certain instances where NASA's financial management systems did not substantially comply with the requirements of FFMIA. Specific issues include information technology controls over the financial systems and the integration of the real property system with the Core Financial module.

In fulfilling our responsibilities under the Chief Financial Officers Act of 1990, we monitored the progress of the audit, reviewed E&Y's reports and related documentation, inquired of its representatives, and ensured that E&Y met contractual requirements. Our

review was not intended to enable us to express, and we do not express, an opinion on NASA's financial statements; conclusions about the effectiveness of internal controls over financial reporting; or compliance with certain laws and regulations, including, but not limited to, FFMIA.

E&Y is responsible for each of the enclosed reports and the conclusions expressed therein. Our review, while still ongoing, disclosed no instances where E&Y did not comply, in all material respects, with the Government Accountability Office's "Government Auditing Standards."

We hope that you find the reports useful. Please contact me if you have questions.

signed

Thomas J. Howard

3 Enclosures

Report of Independent Auditors

To the Administrator and the Acting Inspector General
of the National Aeronautics and Space Administration

We were engaged to audit the accompanying consolidated balance sheets of the National Aeronautics and Space Administration (NASA) as of September 30, 2009 and 2008, and the related consolidated statements of net cost and changes in net position and the combined statements of budgetary resources for the fiscal years then ended. These financial statements are the responsibility of NASA's management.

During fiscal year 2009, NASA continued its focused efforts to resolve long-term issues identified in its financial management processes and systems. Although significant progress has been made, NASA management and our work continue to identify issues related to internal control in its property accounting, principally relating to assets capitalized in prior years. As a result of these limitations, we were unable to obtain sufficient evidential support for the amounts presented in the consolidated balance sheets as of September 30, 2009 and 2008, and the related consolidated statements of net cost and changes in net position and the combined statements of budgetary resources for the fiscal years then ended.

Because of the matters discussed in the preceding paragraph, the scope of our work was not sufficient to enable us to express, and we do not express, an opinion on the consolidated balance sheets as of September 30, 2009 and 2008, and the related consolidated statements of net cost, consolidated statements of changes in net position, and combined statements of budgetary resources for the fiscal years then ended.

The information presented in Management's Discussion and Analysis, required supplementary stewardship information, required supplementary information, and other accompanying information is not a required part of the basic financial statements but is supplementary information required by the Office of Management and Budget (OMB) Circular No. A-136. The other accompanying information has not been subjected to the auditing procedures applied in our audit of the basic financial statements and, accordingly, we express no opinion on it. We were unable to apply to the information certain procedures prescribed by professional standards within the time frames established by OMB because of the limitations on the scope of our audit of the financial statements discussed above.

In accordance with *Government Auditing Standards* and OMB Bulletin No. 07-04, *Audit Requirements for Federal Financial Statements*, as amended, we have also issued our reports dated November 9, 2009, on our consideration of NASA's internal control over financial reporting and on our tests of its compliance with certain provisions of laws, regulations, and other matters. The purpose of those reports is to describe the scope of our testing of internal control over financial reporting and compliance and the results of that testing and not to provide an opinion on the internal control over financial reporting or on compliance. Those reports are an integral part of an audit performed in accordance with *Government Auditing Standards* and OMB Bulletin No. 07-04, as amended, and should be considered in assessing the results of our work.

Ernst & Young LLP

November 9, 2009

Report on Internal Control

To the Administrator and the Acting Inspector General
of the National Aeronautics and Space Administration

We were engaged to audit the financial statements of the National Aeronautics and Space Administration (NASA or the Agency) as of and for the year ended September 30, 2009, and have issued our report thereon dated November 9, 2009. The report states that because of the matters discussed therein, the scope of our work was not sufficient to enable us to express, and we do not express, an opinion on the consolidated balance sheet as of September 30, 2009, and the related consolidated statements of net cost and changes in net position, and the combined statement of budgetary resources for the fiscal year then ended.

In planning and performing our audit, we considered NASA's internal control over financial reporting as a basis for designing our auditing procedures for the purpose of expressing our opinion on the financial statements, but not for the purpose of expressing an opinion on the effectiveness of NASA's internal control over financial reporting. Accordingly, we do not express an opinion on the effectiveness of NASA's internal control over financial reporting. We limited our internal control testing to those controls necessary to achieve the objectives described in the Office of Management and Budget (OMB) Bulletin No. 07-04, as amended. We did not test all internal controls relevant to operating objectives as broadly defined by the Federal Managers' Financial Integrity Act of 1982 (FMFIA), such as those controls relevant to ensuring efficient operations.

Our consideration of internal control over financial reporting was for the limited purpose described in the preceding paragraph and was not designed to identify all deficiencies in internal control that might be significant deficiencies or material weaknesses and, therefore, there can be no assurance that all deficiencies, significant deficiencies, or material weaknesses have been identified. However, as discussed below, we identified certain deficiencies in internal control that we consider to be material weaknesses and other deficiencies that we consider to be significant deficiencies.

A deficiency in internal control exists when the design or operation of a control does not allow management or employees, in the normal course of performing their assigned functions, to prevent, or detect and correct misstatements on a timely basis. A *material weakness* is a deficiency, or a combination of deficiencies, in internal control such that there is a reasonable possibility that a material misstatement of the entity's financial statements will not be prevented, or detected and corrected on a timely basis. We consider the deficiencies related to Enhancements Needed for Controls over Legacy Property, Plant and Equipment (PP&E) and Materials Contracts, to be a material weakness.

A significant deficiency is a deficiency or a combination of deficiencies in internal control that is less severe than a material weakness, yet important enough to merit attention by those charged with governance. We consider the deficiencies related to Processes in Estimating NASA's Environmental Liability Continue to Require Enhancements and Financial Management Systems Not in Substantial Compliance with FFMIA to be significant deficiencies.

Material Weakness

Enhancements Needed for Controls over Legacy PP&E and Materials Contracts, But SFFAS No. 35 Adoption May Aid In Resolving This Longstanding Issue (Modified Repeat Condition)

Prior-year audit reviews of legacy PP&E identified serious weaknesses in the design of internal controls over the completeness and accuracy of legacy assets which prevented material misstatements from being detected and corrected in a timely manner by NASA. Certain legacy issues noted in prior-year audit reports continue to challenge the Agency, particularly in relation to the International Space Station (ISS) and Space Shuttles. During FY 2009, NASA management undertook a systematic process to address the valuation and completeness issues related to the ISS and Space Shuttle assets in anticipation of an FY 2009 release of the Federal Accounting Standards Advisory Board (FASAB) Statement of Federal Financial Accounting Standards (SFFAS) No. 35, *Estimating the Historical Cost of G-PP&E*, which was ultimately released in FY 2010. This standard is expected to substantially improve NASA's ability to account for these assets in accordance with generally accepted accounting principles in FY 2010. Note that Space Shuttle assets will be fully depreciated in FY 2010 as they will have reached the end of their useful lives and this timing coincides with the Space Shuttle Transition program. Adoption of changes in the internal control process associated with new contracts also holds promise in resolving these issues over time.

During the past several years, NASA has continued to revise and correct its records for legacy assets to address these legacy issues. These legacy issues fundamentally flowed from the lack of a robust control structure whereby NASA did not determine at the point of budget formulation, obligation recognition, contract development, accounts payable recognition or disbursement the amounts of property it expects to buy, has contracted for or has purchased. For example:

- In FY 2007, NASA recorded a \$12.7 billion adjustment to write off the net book value (NBV) of legacy assets (previously reported as "theme assets") which it believed were inappropriately capitalized since NASA's implementation of SFFAS No. 6, *Accounting for Property Plant and Equipment*, in FY 1998. NASA recorded this adjustment as a change in accounting principle based upon a technical release issued by the Accounting and Auditing Policy Committee of the FASAB. Prior to this cumulative effect adjustment, the NBV of NASA's PP&E was \$33.3 billion as of September 30, 2006.

- In FY 2008, NASA recorded an adjustment of \$2.9 billion to expense costs previously capitalized as launch costs during the year as these costs were associated with taking foreign-owned components, rather than government-owned components, to the ISS. Prior to this year-end adjustment, the NBV of NASA's PP&E would have been \$24.5 billion as of September 30, 2008. The process to correct this item in FY 2008 was an indicator of the effectiveness of some of the financial management review processes which NASA had been developing, but also highlighted the need for the development of consistent controls regarding capitalization approaches, with appropriately vetted position papers and notification for pending areas of review to ensure that no significant year-end adjustments are needed. As noted below, launch cost calculations were revisited in FY 2009, and additional errors were noted.
- In FY 2009, NASA recorded a series of adjustments during the third and fourth quarters to correct for additional errors in the valuation of legacy assets related to the accounting for launch costs and integration and operational costs capitalized as part of the ISS. During NASA's analysis of the accounting for launch costs, management concluded that prior methodologies and amounts recorded were inaccurate since FY 1998, when the first component of the ISS was carried by the Space Shuttle. Management recorded a \$5.2 billion adjustment to write off the NBV of previously capitalized launch costs. Management revised its methodology during FY 2009 and, based upon its new estimates, it recorded an adjustment of \$84 million to capitalize the NBV of launch costs. In our initial reviews of management's revised methodology, developed in anticipation of the release of SFFAS No. 35, and estimation for capitalized launch costs, we noted that estimates were not fully supported by prior historical cost data, but management believes it has sufficient information to support reasonable estimates of such costs consistent with SFFAS No. 35 which will be effective in FY 2010.

Ongoing efforts by NASA management to develop a robust and rigorous review process that both validates and challenges the adequacy of estimation techniques used and the sufficiency of documentation supporting those conclusions will serve NASA management well in preparing for the audit of these estimates. This type of ongoing control activity is crucial for the Agency as it implements and sustains any estimation modeling for valuing components of its PP&E. For the integration and operational costs, NASA noted that it had been capitalizing Integration and Operations (I&O) costs associated with the ISS after the ISS was placed into service on September 30, 2001. According to NASA's inquiries of an ISS specialist, these costs included ground and flight support, maintenance and repairs and NASA's current financial management team concluded these costs should have been expensed as operation costs and not capitalized. Management recorded a \$1.4 billion adjustment to write off the NBV of previously capitalized I&O costs. Prior to these FY 2009 recorded adjustments, the NBV of NASA's PP&E would have been \$18.1 billion as of September 30, 2009.

Progress has been made in revising NASA's policies and NASA has gained a deeper understanding of the components of its capitalized assets. The adoption of SFFAS No. 35, *Estimating the Historical Cost of G-PP&E*, in FY 2010 provides a unique opportunity for NASA to address the legacy valuation issues which have impaired its ability to prepare auditable financial statements. As noted above, issues regarding whether broad components of PP&E should be recorded have arisen and been addressed over the last several years, in each case calling into question the reliability of prior processes and reported amounts. In connection with critically assessing management's reported amounts for PP&E in FY 2010 and subsequent years, as valuation issues are addressed utilizing the ongoing flexibility in the new FASAB guidance, the need to ensure that property records are complete and property items can be associated with estimates of their original acquisition costs consistent with the guidance in SFFAS No. 35 will loom larger. Subjecting such processes to rigorous self-assessment under management's internal control review process under OMB Circular A-123, *Management's Responsibility for Internal Control*, Appendix A - *Internal Control over Financial Reporting*, and robust assessments of the legacy property records for completeness and accuracy, perhaps in conjunction with ongoing monitoring activities, will serve NASA well in ensuring that reported amounts are complete and reliable. NASA is currently participating in work groups intended to assist agencies in exploring supportable approaches to developing valuation estimates and supporting such amounts to the extent needed to withstand audit processes, with an initial particular focus on contractor-held property. These deliberations may impact NASA and third-party assessments of whether the initial processes developed by NASA in an effort to address anticipated changes in the FASAB literature conform to the financial management community's implementation guidelines for SFFAS No. 35. Going forward, internal controls, which have been revised to account for acquisitions of property under contracts with effective dates after October 1, 2007, hold promise in addressing new acquisitions; however, the effectiveness of such controls cannot currently be assessed pending issuance of new contracts that would be impacted by this policy.

Recommendation

We recommend that NASA:

1. Continue to actively improve implementation of SFFAS No. 35. Areas for particular focus include: (1) appropriate approaches in critically assessing prior recorded amounts for legacy assets when the initial documentation to support recorded amounts is not available, and the extent to which such initial recorded amounts, perhaps in conjunction with budgetary or other collaborative information, can be viewed as reasonable estimates; and (2) the extent to which the entity must associate ongoing outlays with individual items of PP&E versus recording amounts based on contractor-provided estimates in bulk, particularly for legacy contracts which do not contain current NASA requirements intending to aid in identifying when PP&E is being acquired, and NASA's responsibilities to verify reported amounts.

2. Develop an overarching key control activity that provides for a robust and rigorous review that both validates and challenges the adequacy of estimation techniques used and the sufficiency of documentation supporting those conclusions. This type of ongoing control activity is crucial for NASA as it implements and sustains any estimation modeling for valuing components of its PP&E. In addition, management should utilize existing monitoring activities and internal control assessments with a particular emphasis at the Center level in demonstrating that a comprehensive control process has been used to verify that detail property records are complete and reflect all PP&E, are reconciled to the recorded amounts in the general ledger, constitute NASA's best estimates consistent with SFFAS No. 35 of the historical costs of such items and that available information to aid in collaborating such amounts has been validated and appropriately considered.

Significant Deficiencies

Processes in Estimating NASA's Environmental Liability Continue to Require Enhancement (Modified Repeat Condition)

NASA's environmental liability is estimated at \$922 million as of September 30, 2009, including the estimated environmental cleanup cost associated with PP&E. We noted that the NASA Office of the Chief Financial Officer (OCFO) and the Environmental Management Division (EMD) invested resources to resolve our prior-year finding related to the internal controls for the unfunded environmental liability (UEL) estimation process. NASA developed an estimate in September 2009 of the anticipated environmental cleanup costs associated with PP&E, implementing our prior recommendation to develop such estimate in accordance with SFFAS No. 6, *Accounting for Property, Plant, and Equipment*. The joint review process, a key control NASA implemented to enhance its estimation processes, began to mature in FY 2009 and added additional consistency to the UEL estimation process. While NASA continues to make year-to-year progress, we noted weaknesses in NASA's ability to generate an auditable estimate on a timely basis of its UEL environmental cleanup costs and its environmental liabilities associated with PP&E. Specifically:

- While the estimates for environmental costs associated with PP&E were not provided with sufficient time to support the audit process, NASA has acknowledged a need to develop training and controls supporting the development of the estimates, and noted that the estimates were initially developed under severe time constraints and resource limitations. To the extent further such resources and adequate time are devoted to this process, changes in the estimates may emerge. This includes but is not limited to the reclassification of SFFAS No. 5 liabilities to SFFAS No. 6.

- Approximately \$170 million, or 17% of the UEL estimate, is developed using the parametric models within NASA's Integrated Data Evaluation & Analysis Library (IDEAL) estimating software. NASA has not completed the design and implementation of its general and application controls for this model. Examples include: NASA-prepared security plans for IDEAL, in which it indicated that actions to mitigate security risks need to be resolved. NASA finalized its Configuration Management Plan and verification reports for five centers in October 2009. A preliminary assessment noted that the Configuration Management Plan did not address system audits or reporting. We noted that preliminary analysis of the verification reports revealed certain unit costs embedded in IDEAL indicate that such factors may be overstated by 100% and 300%, but NASA has not yet fully assessed how, if at all, to change the models for this finding, or completed an analysis of other such inputs. In addition, NASA has had large year-to-year changes in environmental estimates, due in part to varying interpretations of certain markup definitions in the software and, as discussed below, revisions to its process used in assessing the number of years for which sufficiently reliable cost estimates can be developed.
- During FY 2009, NASA revised its estimation process to reflect that in general UEL estimates for the first 30 years of a project's lifespan will be recorded as a liability in the NASA financial statements. While the guidance is under continued revision, it is our understanding that if a sufficiently reliable engineering estimate has been developed beyond this 30-year period, such estimate will be considered in developing the accrual. This revision in the estimation process resulted in an approximate 25% reduction in the accrual for the related estimates. The process to develop this revision in NASA's procedures called into question the extent of coordination between OCFO and EMD, with aspects of the policy as initially articulated not conforming to GAAP. In addition, no formalized process for calculating and aggregating the SFFAS No. 5 reasonably possible estimate has been established. In FY 2009, an initial reasonably possible estimate was intended in part to capture the portion of long-term UEL estimates which exceeded 30 years and by definition, under NASA's policy, was judged not to be sufficiently reliable to record in the accrual, calling into question the reliability of the information for disclosure purposes as well. The estimate was compiled and aggregated by EMD with little support from the individual project managers, and OCFO was not aware of the process.

Recommendation

As it relates to the estimation of environmental liabilities, we recommend that NASA:

1. Enhance and formalize the process it has developed to estimate environmental cleanup costs under SFFAS No. 6, *Accounting for Property, Plant, and Equipment*, including dedicating additional resources to ensure compliance with the requirements, implementing internal controls and developing training. To the extent a portion of the previously reported environmental liability estimates subsume closure costs more appropriately recognized under SFFAS No. 6, NASA financial reporting can be enhanced by reclassification of footnote disclosures for such costs.
2. Complete the development and implementation of general and application controls as they relate to IDEAL. The initial focus should be on demonstrating the accuracy of both the parametric model and aggregation output. An alternative recommendation is to use a commercially available software tool that already meets these conditions.
3. Recode IDEAL to simplify markup inputs. For example, at present, the prime contractor markup is comprised of two embedded components to capture markup for the prime contractor and subcontractor, which should be revised to only allow input for one NASA component at a time. Re-emphasize in the annual training provided to NASA's center EMD and OCFO personnel the explanations of these entries.
4. Implement preventative actions (i.e., controls) to address change management for accounting policy alterations to environmental liabilities and implement rigorous quality control efforts regarding associated footnote disclosures of reasonably possible and recorded amounts, including explicit discussion and conclusion on these items in the joint review process. Assign roles and responsibilities for implementation and for proper communication throughout the organization.

Financial Management Systems Not in Substantial Compliance with FFMIA (Modified Repeat Condition)

NASA's financial management systems are not substantially compliant with the Federal Financial Management Improvement Act of 1996 (FFMIA). During FY 2009, as discussed above, NASA management took action to address its noncompliance with the FFMIA. Although these steps corrected certain weaknesses noted during the past five years, other weaknesses continue to exist. Specific weaknesses noted include the following:

- The real property system is not integrated with the Core Financial Module.

- Issues related to access and change management were noted as a result of information technology (IT) audit procedures. The level of risk associated with these IT issues depends in part upon the extent to which financial-related compensating controls (such as reconciliations and data integrity reviews of output) are in place and operating effectively throughout the audit period. Certain of these controls designed to detect errors or inappropriate processing may also not be executed in a manner which can be expected to identify errors, which, while perhaps not material to the financial statements as a whole, may subject NASA to risks regarding safeguarding of assets. Although NASA has made progress in addressing and resolving prior-year IT findings, these IT-related issues, along with issues noted by Ernst & Young, the Government Accountability Office (GAO) and the NASA Office of Inspector General (OIG) in their reviews through the year, merit continued management focus.
- NASA was unable to meet certain requirements to ensure compliance with federal accounting standards, as discussed in various sections within this report.

Recommendation

We recommend that NASA:

1. Move forward to integrate government-held real property transactions into the Asset Accounting Module of SAP in February 2010 and continue efforts to integrate recording of PP&E transactions contemporaneous with their occurrence,
2. Resolve issues identified during our IT procedures in our audit related to access and change management surrounding its financial management systems.

Other Matters

Summary of FY 2008 Material Weaknesses

Issue Area FY 2008	Summary Control Issue FY 2008	FY 2009 Status
Material Weaknesses		
Financial Systems, Analyses, and Oversight	<ul style="list-style-type: none"> • Continuous Monitoring Program • Financial Statement Preparation Process • Continued Efforts needed to Resolve Data Integrity Issues • Processes in estimating NASA’s Environmental Liabilities continue to require enhancements. • Financial management systems not in substantial compliance with FFMIA. 	Significant improvements noted. Aspects related to UEL and FFMIA compliance reported as significant deficiencies.
Enhancements Needed for Controls over PP&E and Materials Contracts	<ul style="list-style-type: none"> • Enhancements Needed for Controls over Legacy PP&E and Materials Contracts 	Improvements noted pending SFFAS No. 35 adoption. Modified repeat condition.

* * * * *

We have reviewed our findings and recommendations with NASA management. Management generally concurs with our findings and recommendations and will provide a corrective action plan to address the findings identified in this report.

This report is intended solely for the information and use of the management and the OIG of NASA, OMB, GAO and Congress, and is not intended to be and should not be used by anyone other than these specified parties.

Ernst & Young LLP

November 9, 2009

Report on Compliance with Laws and Regulations

To the Administrator and the Acting Inspector General
of the National Aeronautics and Space Administration

We were engaged to audit the financial statements of the National Aeronautics and Space Administration (NASA) as of and for the year ended September 30, 2009, and have issued our report thereon dated November 9, 2009. The report states that because of the matters discussed therein, the scope of our work was not sufficient to enable us to express, and we do not express, an opinion on the consolidated balance sheet as of September 30, 2009, and the related consolidated statements of net cost and changes in net position, and the combined statement of budgetary resources for the fiscal year then ended.

The management of NASA is responsible for complying with laws and regulations applicable to NASA. We performed tests of its compliance with certain provisions of laws and regulations, noncompliance with which could have a direct and material effect on the determination of financial statement amounts, and certain other laws and regulations specified in Office of Management and Budget (OMB) Bulletin No. 07-04, *Audit Requirements for Federal Financial Statements*, as amended, including the requirements referred to in the Federal Financial Management Improvement Act of 1996 (FFMIA). We limited our tests of compliance to these provisions, and we did not test compliance with all laws and regulations applicable to NASA.

The results of our tests disclosed no instances of noncompliance with the laws and regulations discussed in the preceding paragraph exclusive of FFMIA that are required to be reported under *Government Auditing Standards* or OMB Bulletin No. 07-04, as amended.

Under FFMIA, we are required to report whether NASA's financial management systems substantially comply with federal financial management systems requirements, applicable federal accounting standards and the United States Standard General Ledger (SGL) at the transaction level. To meet this requirement, we performed tests of compliance with FFMIA Section 803(a) requirements. However, as noted above, we were unable to complete our audit. Based upon the results of the tests we were able to complete, we noted certain instances, described below, in which NASA's financial management systems did not substantially comply with certain federal system and federal accounting standard requirements:

- The real property system is not integrated with the Core Financial Module.

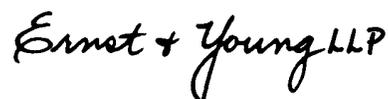
- Issues related to access and change management were noted as a result of information technology (IT) audit procedures. The level of risk associated with these IT issues depends in part upon the extent to which financial-related compensating controls (such as reconciliations and data integrity reviews of output) are in place and operating effectively throughout the audit period. Certain of these controls designed to detect errors or inappropriate processing may also not be executed in a manner which can be expected to identify errors, which, while perhaps not material to the financial statements as a whole, may subject NASA to risks regarding safeguarding of assets. Although NASA has made progress in addressing and resolving prior-year IT findings, these IT-related issues, along with issues noted by Ernst & Young, the Government Accountability Office (GAO) and NASA Office of Inspector General (OIG) in their reviews through the year, merit continued management focus.
- NASA was unable to meet certain requirements to ensure compliance with federal accounting standards, as discussed in various sections of the Report on Internal Control.

Our Report on Internal Control includes information related to the financial management systems that were found not to comply with the requirements, relevant facts pertaining to the noncompliance and our recommendations related to the specific issues presented. It is our understanding that NASA's management generally agrees with the facts as presented and that relevant comments from NASA's management responsible for addressing the noncompliance are provided as an attachment to this report. We did not audit management's comments and, accordingly, we express no opinion on them.

Because we could not complete our audit, we were unable to determine whether there were other instances of noncompliance with laws and regulations that are required to be reported.

Providing an opinion on compliance with certain provisions of laws and regulations was not an objective of our audit and, accordingly, we do not express such an opinion.

This report is intended solely for the information and use of management and the OIG of NASA, OMB, GAO, and Congress, and is not intended to be and should not be used by anyone other than these specified parties.

A handwritten signature in cursive script that reads 'Ernst & Young LLP'.

November 9, 2009

National Aeronautics and Space Administration
Headquarters
Washington, DC 20546-0001



November 16, 2009

Reply to Attn of:

Office of the Chief Financial Officer

TO: Inspector General

FROM: Deputy Chief Financial Officer

SUBJECT: Management's Response to Independent Auditors' Report for
Fiscal Year 2009

I appreciate the efforts of the Office of Inspector General (OIG), and of the independent auditors under contract with the OIG, to audit the National Aeronautics and Space Administration's (NASA) FY 2009 financial statements. NASA's resolution of the prior year material weakness related to financial systems, analyses, and oversight is a direct result of commitment and focused effort from the entire Agency. This reflects NASA's continuing progress toward an improved audit opinion.

I understand that, due to weaknesses in NASA's internal control over legacy property and materials contracts, the independent auditors were unable to obtain sufficient evidential support for the amounts presented in the Agency's financial statements. Therefore, the auditors did not express an opinion on the consolidated balance sheets as of September 30, 2009 and September 30, 2008, and the related consolidated statements of net costs and changes in net position, and the combined statements of budgetary resources for the fiscal years then ended.

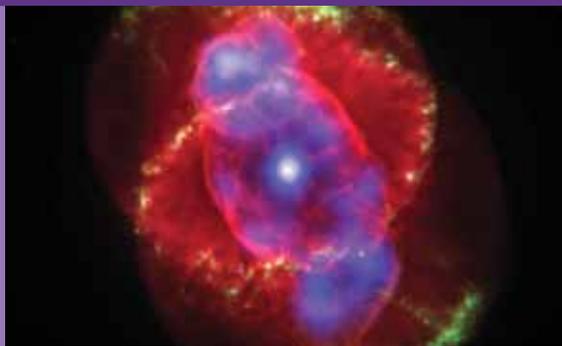
The Agency is committed to resolving the legacy property weaknesses, particularly through the guidance contained in the recently released Statement of Federal Financial Accounting Standard 35, Estimating the Historical Cost of General Property, Plant, and Equipment. We will also continue to address the noted deficiencies related to estimates for unfunded environmental liabilities and compliance with the Federal Financial Management Improvement Act.

A handwritten signature in blue ink that reads "Terry Bowie".

Terry Bowie



Other Accompanying Information



Office of Inspector General Letter on NASA's Most Serious Management and Performance Challenges

November 13, 2009

TO: Administrator
FROM: Acting Inspector General
SUBJECT: NASA's Most Serious Management and Performance Challenges

As required by the Reports Consolidation Act of 2000, this memorandum provides our views of the most serious management and performance challenges facing NASA and is to be included in the Agency's Performance and Accountability Report for fiscal year 2009.

In determining whether to report an issue as a challenge, we consider the significance of the issue in relation to the Agency's mission; its susceptibility to fraud, waste, and abuse; whether the underlying problems are systemic; and the Agency's progress in addressing the issue. We provided a draft copy of our views to Agency officials and considered all comments received.

Through various Agency initiatives and by implementing recommendations made by the Office of Inspector General (OIG) and other evaluative bodies, such as the Government Accountability Office, NASA is working to improve Agency programs and operations. However, challenges remain in the following areas:

- Transitioning from the Space Shuttle to the Next Generation of Space Vehicles
- Managing Risk to People, Equipment, and Mission
- Financial Management
- Acquisition and Contracting Processes
- Information Technology Security

During FY 2010, the OIG will continue to conduct work that focuses on NASA's efforts to meet these challenges as part of our overall mission to promote the economy and efficiency of the Agency and to root out fraud, waste, abuse, and mismanagement.

We hope that you find our views helpful. Please contact me if you have questions.

signed
Thomas J. Howard

Enclosure:
NASA's Most Serious Management and Performance Challenges

NASA's Most Serious Management and Performance Challenges

Transitioning from the Space Shuttle to the Next Generation of Space Vehicles

NASA's greatest challenge continues to be maintaining the critical skills and capabilities required to safely and effectively fly the Space Shuttle until its retirement while transitioning to the next generation of space vehicles. In 2004, the "President's Vision for U.S. Space Exploration" caused a substantive reorganization of NASA's strategic priorities, established a timeline for the retirement of the Space Shuttle, established the completion date for the International Space Station (ISS), and set the goals of returning to the Moon and reaching Mars. However, fiscal realities and technical challenges have hampered NASA's efforts to effectively implement the Vision.

Space Shuttle Program. The primary mission focus of the Space Shuttle Program between now and retirement is to launch and assemble U.S. and international components for the ISS while sustaining logistics and science support to ISS crews. Successful completion of the Space Shuttle Program's planned manifest, currently scheduled for completion by the end of fiscal year (FY) 2010, is key to meeting NASA's strategic goals of supporting the safe operation of the Space Shuttle to complete assembly of the ISS by the Space Shuttle's planned retirement.

NASA continues to fund and plan for completion of the remaining Space Shuttle flight manifest, which is required to complete the ISS, by September 30, 2010. However, indications from historical flight rates, the presidentially directed Review of U.S. Human Space Flight Plans Committee (the Augustine Committee), internal NASA evaluations, and work by the NASA Office of Inspector General (OIG) show that this goal is not likely to be achieved by the end of FY 2010. If NASA is required to extend the Shuttle's flight schedule, the Agency will need to reevaluate the adequacy of funding and plans for the sustainability of the Shuttle's workforce and infrastructure while preserving the robust process for voicing safety and engineering concerns.

Constellation Program. NASA began the Constellation Program in 2005 to facilitate the President's Vision for return to the Moon and the human exploration of Mars. However, reviews of various components of the Program have concluded that allotted resources are not sufficient for stated requirements.

The largest expenditure of funds within the Constellation Program—\$10 billion—has been for the development of the Ares I crew launch vehicle and the Orion crew exploration vehicle. Yet, according to the Government Accountability Office (GAO), NASA cannot confidently determine total costs until technical challenges have been overcome. Engineers working on the Ares I Project continue their efforts to understand and mitigate the impact of rocket thrust oscillations that some critics contend could threaten the health of astronauts and survivability of the Orion vehicle. To improve cost and schedule confidence, NASA has modified Orion's baseline configuration for initial missions, reducing the number of astronauts the vehicle will transport from six to four. To accommodate the resolution of these and other technical issues, project milestones have rightfully been delayed. NASA's meticulous application of a disciplined approach for each life-cycle phase review will help ensure that complete, timely, and essential information is provided for informed decision making.

Unity of effort is essential for executing a program as complex as Constellation within the fiscal resources provided while ensuring the safe, efficient, and effective implementation of its projects, such as Orion. Over the past year, the Constellation Program has been the subject of multiple studies and analyses. In addition to internal life-cycle reviews associated with standard program management, reviews conducted by the Agency for the President, OIG, GAO, and the Augustine Committee have all examined and reported on the progress of various components of the Constellation Program. Each review noted that allotted resources did not match stated requirements, which resulted in the modification of requirements and the delay of significant milestones.

Managing the Transition. NASA faces several transition challenges, among the greatest are the gap period between the last planned Shuttle flight in 2010 and the first planned Ares I and Orion flight in 2015, the sustainment of the ISS after the last Space Shuttle mission, and the effective management of civil service and contractor personnel assigned to the Space Shuttle Program and the Constellation Program.

Over the past year, at the request of Congress and the Administration, NASA has provided various options for extending Shuttle operations and closing the gap between the planned retirement of the Space Shuttle and the first piloted space flight of the Constellation Program's Orion crew exploration vehicle. While each option is technically

feasible, each option results in a higher cumulative safety risk because each involves an increased number of Space Shuttle flights, and additional funding would be required to avoid negatively impacting implementation of the next generation of space vehicles.

Two plans that NASA developed—one for an extension of the Shuttle Program to 2012 and another for extension to 2015—would cost an estimated \$4.7 billion and \$14 billion, respectively. These costs would have to be taken out of other NASA programs unless they were provided as an addition to the baseline budget. Each plan would require close coordination with the Constellation Program to avoid negatively impacting the development and implementation of the Program. In addition, the Columbia Accident Investigation Board recommended in 2003 that, as part of a Service Life Extension Program, NASA should recertify the Shuttle at the material, component, system, and subsystem levels prior to operations beyond 2010. Additional challenges to any plan to extend the Shuttle Program include recertifying suppliers who have already begun retooling efforts and reversing recent contract workforce layoffs.

The Augustine Committee presented eight options to address the gap in U.S. space flight capability; six of the options included extending ISS operations from 2015 to 2020, potentially making ISS sustainment more challenging. Providing for the sustainment of ISS is crucial to realizing the scientific research potential of the ISS and protecting the extensive U.S. and foreign investments in the ISS. NASA plans to rely on international partners and commercial providers for logistics support and crew rotation necessary to sustain and operate the ISS during the gap period of 2010 through 2015. However, while viewed by Agency officials as unlikely, there are various ISS components that can only be carried to orbit by the Space Shuttle should they have to be replaced. In addition, NASA plans to rely on the commercial sector to develop space vehicles for the bulk of cargo delivery required to maintain an ISS crew of six. However, a recent GAO report stated that although the commercial providers have made some progress in meeting established milestones, demonstration flights of their vehicles have been delayed due to engine development challenges. Significant delays in the availability of these commercial vehicles could threaten sustainment of the ISS.

Workforce issues during the gap period of 2010 through 2015 include maintaining the critical skills now present in the Shuttle workforce throughout the Shuttle's remaining flights while placing additional emphasis on defining and cultivating the skill sets needed by the Constellation Program, especially those that will be needed at Kennedy Space Center. Although other NASA Centers are engaged in development and production activities for the new vehicles, the primary focus of the Kennedy workforce is launch operations and ground processing—activities that will not be needed at levels similar to current capacity until the new crew exploration vehicles are ready for flight. Determining the appropriate balance to operate the Space Shuttle safely and sustain that program through retirement while incentivizing talented people to prepare for the future requirements of the Constellation Program demands the optimization of all human resource management assets.

Recognizing the significance of the transition being properly managed, various NASA councils (e.g. Program Management Council, Operation Management Council, and Strategic Management Council) routinely review the Space Shuttle retirement plan and progress, to include transition metrics, decisions, and impact on facilities. In addition, in July 2009, NASA published the third edition of the "NASA Workforce Transition Strategy," which detailed civil service and contractor Shuttle and Constellation workforce projections and requirements at NASA's individual Centers. As the Shuttle Program is retired and the Constellation Program enters the implementation phase of development, such efforts should entail greater detail and transparency to enable informed decision making.

Managing Risk to People, Equipment, and Mission

Ensuring the success of NASA's mission is the goal of effective risk management. Safety and mission assurance controls are key to supporting robust and reliable operations in the context of very challenging launch and mission schedules. NASA program managers are constantly confronted with risks introduced by fiscal realities, schedule demands, and ever-changing priorities. In addition, the NASA OIG has investigated instances involving damaged, counterfeit, or inferior parts purchased by NASA as a result of questionable or even criminal actions of suppliers. Technical challenges, competition for scarce resources, and U.S. economic constraints add risk to international and commercial partnerships. Close scrutiny by NASA management of adherence to the fundamentals of project and program management, risk identification and mitigation, and proven acquisition strategies is beneficial toward the accomplishment of Agency goals.

Technical Challenges. Although there is evidence of a continued, strong engineering and safety focus, technical issues continue to challenge the Shuttle Program and add risk to mission success. Specifically, NASA most recently has been troubleshooting hydrogen gas leaks and valve concerns and continued addressing the risk posed by the shedding of foam insulation from the external fuel tank. Undoubtedly, there will be unforeseen technical

challenges that will need to be addressed as long as the Space Shuttle continues operations. The stress added to schedules and budgets in an effort to meet these technical challenges is compounded by stress generated in trying to maintain the Constellation Program's development and acquisition schedule.

Ongoing technical challenges and failures in the Science Mission Directorate portfolio add to Agency stress and increase the cost of NASA programs and projects. NASA's next high-profile mission to Mars, the Mars Science Lab, suffered a major setback resulting in a missed launch opportunity in 2009, a \$400 million cost increase, and a 2 year schedule delay due to technical challenges. These challenges threaten the viability of the project, and cost increases and schedule delays may significantly impact the entire Mars Exploration Program. In addition, the Orbiting Carbon Observatory, a satellite important to the monitoring and understanding of the Earth's changing climate, suffered an undetermined technical failure on launch, resulting in the loss of the \$209 million satellite and arguably creating a gap in NASA's execution of the recommendations and intent of the National Research Council's Earth Science Decadal Survey. NASA is also continuing to work on resolving technical issues that threaten to further delay implementation of the Stratospheric Observatory for Infrared Astronomy Program, which is now 10 years behind schedule with costs exceeding 200 percent of the initial cost estimate.

Sound program and project management principles, technical and safety risk identification, and sound mitigation strategies are paramount to successfully developing and operating programs and projects that push the envelope of technological advancement. In the past year, the OIG dedicated considerable resources to reviewing the Agency's risk management efforts at the program and project levels. Although the management of risk generally appeared sound, life-cycle reviews needed to remain focused on ensuring appropriate maturity of design and emphasis was needed on ensuring the adequacy of benefit-cost analyses to provide required information for informed decision making. Our focus will continue to include monitoring NASA's implementation of requirements detailed in the NASA Policy Directive 7120 series on program and project management as well as NASA's implementation of GAO best practices and OIG recommendations.

Budgetary Challenges. Aside from the tremendous schedule and technical challenges associated with the complex science, aeronautics, and space exploration projects undertaken by NASA, accomplishment of those missions is susceptible to budgetary revisions imposed through the appropriations process. The implications associated with this budgetary reality add ever-increasing risk to an organization responsible for leading the Nation in space and aeronautics research and development and whose programs are designed to operate over several decades.

Budget revisions and the emphasis on implementing the President's Vision, National Academy of Sciences recommendations, and other stakeholder priorities also influence operations within the NASA Directorates not directly involved in the Space Shuttle or Constellation Programs. While the major space exploration and operational program challenges continue to be a difficult balancing act, other Mission Directorates within NASA, such as the Aeronautics Research Mission Directorate (ARMD) and the Science Mission Directorate, certainly feel the impact. Shifting priorities and inconsistent funding levels have delayed the development and implementation of the Landsat Data Continuity Mission and Global Precipitation Measurement projects. Decreasing budget allocations have influenced decisions throughout the ARMD portfolio, including research and development activities for the Next Generation Air Transportation System.

NASA is required to operate within the fiscal boundaries afforded and supported by the public interest. Although NASA's programs have advanced the Nation's knowledge in science and technology, the many issues facing the country have led to questions about the cost and benefits of space exploration. The debate will likely intensify as the Administration and Congress weigh the options presented by the Augustine Committee.

Key Partnerships. In light of NASA's budgetary realities, international and commercial partnerships are vital to not only implementing the President's Vision, but also improving the viability of future inter-planetary and deep-space exploration. Such partnerships involve risks that include changes in U.S. foreign relations policy and economic constraints.

The President's Vision directed NASA to pursue opportunities for international partnerships in support of the Nation's exploration goals. The Augustine Committee reaffirmed the benefits of engaging international partners in future space exploration endeavors, stating that many nations have aspirations for space exploration and U.S. leadership "could strengthen geopolitical relationships, leverage global resources, and enhance the exploration enterprise." In addition to NASA's traditional partners (Canada, France, Japan, etc.), other countries (e.g., China) that have not traditionally been considered as partners for various reasons are developing space programs, which could prove to be an asset in the future to NASA in attaining its goals.

The looming gap in U.S. human space flight capability makes engagement, cooperation, and consideration of alternatives a must for the viability of the ISS. NASA is facing significant challenges to its plan to honor its commitments to deliver cargo to the ISS. Delays in the Commercial Orbital Transportation Services Program and the likely unavailability of U.S. made crew vehicles increase the likelihood that NASA will be forced to rely solely on international partners to transport cargo and crew to the ISS.

Financial Management

Over the past year, NASA continued to make progress in improving its internal control over financial reporting by executing its Continuous Monitoring Program (CMP). The CMP assesses and evaluates internal controls, compliance with generally accepted accounting principles, and evidence used to support that balances and activity reported in NASA's financial statements are accurate and complete by requiring Centers to perform a set of control activities. Throughout FY 2009, the CMP has operated as designed. NASA has identified exceptions through the execution of the control activities and has generally tracked and resolved those exceptions in a timely manner.

Although much progress has been made in developing policies, procedures, and controls to improve NASA's financial processes and systems, challenges remain. Specifically, during FY 2009, NASA management and Ernst & Young LLP (E&Y) continued to identify deficiencies in the Agency's system of internal control, which impair NASA's ability to timely report accurate financial information. The most severe deficiency involves NASA's internal control over legacy property, plant, and equipment (PP&E). As shown in the following table, this deficiency has been reported as a material weakness for several years.

Internal Control Deficiencies						
Fiscal Year		2009	2008	2007	2006	2005
Independent Public Accountant		E&Y	E&Y	E&Y	E&Y	E&Y
Audit Opinion		Disclaimer	Disclaimer	Disclaimer	Disclaimer	Disclaimer
Internal Control Deficiencies	Property, Plant, and Equipment	material weakness	material weakness	material weakness	material weakness	material weakness
	Financial Statement Preparation Process and Oversight	—	material weakness	material weakness	material weakness	material weakness
	Environmental Liability Estimation ^a	significant deficiency	—	—	—	reportable condition
	Federal Financial Management Improvement Act ^b	significant deficiency	—	—	—	—
	Fund Balance with Treasury	—	—	—	—	material weakness
^a The deficiency cited for Environmental Liability Estimation was included in the Financial Statement Preparation Process and Oversight weakness for FYs 2006–2008.						
^b The deficiency cited for Federal Financial Management Improvement Act was included in the Financial Statement Preparation Process and Oversight weakness for FYs 2005–2008.						

Property, Plant, and Equipment. To address the PP&E material weakness, NASA implemented a PP&E capitalization policy and procedures for assets procured on or after October 1, 2007. The policy and procedures are intended to ensure that the value and completeness of capitalized assets, whether Government-held or contractor-held, will be accurate. For contracts with effective dates on or after October 1, 2007, contractors are required to report the cost of each capitalized asset as a separate item on required contractor cost reports. NASA also designed a process to reconcile the monthly contractor cost reports and the capitalized PP&E amounts recorded in NASA's Contractor-Held Asset Tracking System (CHATS) and the Core Financial module. However, given that NASA had no new contracts that fell into this category during FY 2009, E&Y could not test the effectiveness of NASA's controls surrounding those reconciliations for contractor-held property.

Currently, the weakness in PP&E is focused primarily on controls over legacy assets that flow from contracts executed prior to October 1, 2007. The most significant of these legacy assets are the ISS and the Shuttle. For several years, audits of these legacy assets have identified serious weaknesses in internal controls over the

completeness and accuracy of the value of the assets. As a result, Agency management and E&Y have been unable to obtain sufficient evidentiary support for the amounts presented in the financial statements.

On October 14, 2009, the Federal Accounting Standards Advisory Board issued an accounting standard clarifying that reasonable estimates of historical cost may be used to value general PP&E. The standard clarifies that Federal entities should report their general PP&E based on historical cost in accordance with the asset recognition and measurement provisions of the earlier property accounting standards. However, the standard allows for reasonable estimates of historical cost to be used to value general PP&E assets. The proper and effective implementation of the new accounting standard will be important in remediating this deficiency regarding legacy capital assets.

In preparation for the issuance of the new accounting standard, NASA performed an analysis of costs that were capitalized for major components of the ISS and Shuttle. NASA undertook a similar effort when it changed its accounting policy for PP&E in FY 2007 and reclassified almost \$13 billion of costs previously categorized as general PP&E to research and development costs.

During its analysis in FY 2009, NASA changed its capitalization policy for Integration and Operations costs associated with the ISS after it was placed into service on September 30, 2001. NASA also changed its policy for capitalizing Shuttle launch service costs associated with the ISS. These policy changes resulted in the reclassification of approximately \$11 billion of ISS costs that were previously capitalized. Many of the adjustments affected prior periods and are recorded as a correction of an error in the financial statements.

Due to the volatility of the property balances and the increased risk of recording estimates for property, PP&E remains a significant management challenge. Ongoing efforts by NASA management to develop a robust and rigorous review process that both validates and challenges the adequacy of estimation techniques used and the sufficiency of documentation supporting those conclusions will serve NASA management well in preparing for the audit of these estimates in the future.

Environmental Liability Estimation. Over the past several years, NASA has taken proactive measures to improve its financial statement preparation processes and oversight. As a result, this issue is no longer reported as a material weakness for FY 2009; however, NASA has challenges estimating its unfunded environmental liability (UEL). These challenges include establishing an Agency-wide policy and ensuring consistent implementation of the policy across the Agency.

During FY 2009, NASA changed the timeframe it uses to estimate its environmental liability to clean-up contaminated sites. NASA now limits the length of the remediation period included in the UEL accrual estimates at 30 years as of the Balance Sheet date. According to NASA, beyond a 30-year horizon, UEL estimates have not proven to be reliable for presentation in the financial statements. While NASA's guidance regarding UEL estimates is under continued revision, NASA has articulated that reliable engineering estimates beyond the 30-year period will be taken into consideration while developing the accrual. However, no amounts in the FY 2009 accrual relate to periods past the 30-year horizon.

NASA developed a policy in September 2009 to capture cleanup costs for removing, containing, and/or disposing of hazardous waste from property or material associated with the permanent or temporary shutdown of a program. The Federal accounting standard that requires agencies to capture this information when applicable property is placed into service has been in effect since FY 1998; however, in September 2009, NASA made its first attempt to estimate and disclose those costs in the financial statements. In addition, E&Y found that NASA does not apply mark-ups (i.e., percentage increases applied to environmental liability estimates to account for contingencies) consistently to remediation projects from year to year, thus creating large variances in the UEL estimate when no other factors had changed. Generally, contingencies should not be changed from year to year unless there is appropriate justification. All of these issues contributed to NASA not having a stable and auditable UEL estimate.

Acquisition and Contracting Processes

One of NASA's long-standing management challenges relates to systemic weaknesses identified in its acquisition and contracting processes. GAO first identified NASA's contract management as a high-risk area in 1990, citing NASA's undisciplined cost-estimating processes in project development, the project managers' inability to obtain information needed to assess contract progress, and persistent cost growth and schedule slippage in the majority of its major projects. GAO noted improvements to NASA's processes in its most recent update to the high-risk areas, "High Risk Series: An Update" (GAO-09-271, January 2009), that included the development of a plan to address systemic weaknesses while noting that "it will take several years to fully implement these initiatives and transform the

agency into an organization that delivers the kind of analysis and forward-looking information needed to effectively manage its many complex programs.” During 2009, the OIG also noted NASA’s continued emphasis on monitoring this challenge and implementing disciplined acquisition management processes. However, both GAO and OIG audits and investigations continue to reveal systemic weaknesses in the areas of acquisition and procurement, to include awards as part of the Small Business Innovation Research (SBIR) Program.

Cost Estimates. In recent reviews of selected NASA programs, the OIG found that NASA still lacks the disciplined cost-estimating processes and financial and performance management systems needed to establish priorities, quantify risks, and manage program costs. Our review of the Stratospheric Observatory for Infrared Astronomy Program found that initial cost estimates were inaccurate and continuously increased as the Program progressed, and our review of the FY 2008 budget request for the Constellation Program found that cost estimates could have been better documented. Given that NASA programs and projects have historically experienced cost overruns, improvements in cost estimating with detailed, empirical data that explain the rationale for decisions could help minimize the risk of cost overruns by providing additional assurance that budget requests are adequate to achieve program and project goals.

GAO has also reported that NASA faces disparate challenges in estimating the cost to retire the Space Shuttle and transition to the Constellation Program. Although NASA continues to budget and manage the launch schedule to retire the Shuttle in 2010, it has yet to decide which facilities and equipment will transition to the Constellation Program and which will be sold, demolished, or preserved for historic value. Proper estimation of the cost to transition and dispose of its facilities and assets are critical to the long-term financial planning for the Constellation Program. According to GAO, NASA will need to determine the status of as many as 654 facilities, worth an estimated \$5.7 billion, and equipment estimated at \$12 billion. NASA continues to focus its efforts to address these challenges on providing improved estimates of transition costs.

Acquisition Process. GAO and OIG audits have continued to report systemic weaknesses involving NASA’s acquisition process. This year there were bid protests involving significant NASA programs pertaining to missteps in the NASA acquisition process. The bid protests cost the Agency in many ways—through delaying the furtherance of the mission for which the contract was being let, through costs generated by the bid protest process itself, and through the costs associated with maintaining the operational status quo. Given that NASA spends approximately 90 percent of its budget on contracts and awards, these systemic weaknesses pose significant challenges to NASA’s ability to make informed investment decisions. In response to this challenge, NASA revised its acquisition policy in 2007, which was a positive step in improving NASA’s ability to complete its programs and projects within cost, schedule, and performance parameters. However, implementation of the revised policy has created its own challenges by fundamentally changing NASA’s approach to acquisition.

In June 2007, the OIG initiated an audit of the Orion Project because it was one of the first space flight projects to implement the revised program and project management policy, which requires space flight projects to conduct life-cycle reviews during each phase of the project’s life cycle. These reviews are considered essential elements of conducting, managing, evaluating, and approving space flight projects. However, during our audit of the Orion Project, we found that NASA conducted a life-cycle review with a vehicle configuration that was not at the proper maturity level to proceed to the next phase. As a result, a significant portion of the vehicle configuration that eventually did proceed to the next phase had not been completely evaluated for compliance with requirements, which increased the risk of costly rework and schedule delays.

More than 3 years ago, GAO testified that NASA’s acquisition strategy of awarding a long-term contract for the design, development, production, and sustainment of Orion before developing a sound business case placed the project at risk of significant cost overruns, schedule delays, and performance shortfalls. Later, in October 2007, GAO noted that gaps in the Ares I Project included inadequate knowledge of requirements, costs, schedule, technology, design, and production feasibility. GAO also noted that, given the complexity and interdependence within the Constellation Program, these challenges were significant. In April 2008, GAO again testified that while NASA was working toward a preliminary design review for Ares I and Orion, there were considerable unknowns as to whether NASA’s plans could be executed within schedule and cost parameters because NASA was still in the process of defining many performance requirements. Most recently, GAO stated that Constellation Program cost and schedule uncertainties persist because “NASA is still struggling to develop a solid business case—including firm requirements, mature technologies, a knowledge-based acquisition strategy, a realistic cost estimate, and sufficient funding and time—needed to justify moving the Constellation program forward into the implementation phase.” The persistence

of this identified systemic weakness in NASA's most valuable program warrants scrutiny and immediate action to ensure the achievement of strategic goals.

Contract Management. With approximately 90 percent of NASA's annual budget used for procuring material and services via contracts and grants, careful attention to the proper administration and monitoring of these vehicles is in the best interest of NASA and the taxpayer. Over the past year, the OIG focused considerable effort in this area and noted several weaknesses.

One of GAO's criticisms of NASA's contract management is the Agency's inability to control cost. The NASA supplement to the Federal Acquisition Regulation (FAR) contains specific provisions to monitor contractor's cost control performance. However, OIG found that NASA project managers deemphasized the importance of controlling costs, minimized the effectiveness of cost control, and gave the contractors minimal incentives to control costs. Specifically, NASA managers did not include cost control measures weighted at no less than 25 percent of the total weighted award evaluation factors. This resulted in the unsupported payment of award fees of \$16 million and 27 months of contract term extensions, valued at \$3.375 billion in one contract and \$233,600 on another, that were not in compliance with the regulation.

GAO has also questioned the effectiveness of award fee type contracts, which are intended to inspire better contractor performance but require significant oversight and documentation to justify the award. We found several instances in which a lack of oversight and documentation resulted in questionable awarding of these fees. Specifically, in one instance we found that performance evaluation factors used to assess a contractor's performance were not sufficiently specific, did not provide the basis for a fair and objective assessment of the contractor's performance, and provided little evidence that the approximately \$2.2 million in award fees were fully justified or an accurate reflection of the contractor's performance. Similarly, in another instance, not only did we question the appropriateness of the award fee type contract but because the Agency's performance evaluations were incomplete and did not comply with guidance, NASA's overall assessment of the contractor performance may have been overstated.

As a result of GAO and OIG findings and recommendations, the Office of Procurement has made several changes to help improve the management of contracts. Specifically, the NASA supplement to the FAR has been revised to require documentation of a cost benefit analysis to support the use of award fees, the management of award fee contracts is being reviewed during the Procurement Management Reviews at each Center, and award fee ratings on selected programs and projects are reviewed during the monthly Baseline Performance Review. OIG will continue to monitor these efforts and evaluate their effectiveness in future work.

Small Business Innovation Research Program. OIG work has identified instances of fraud, waste, and abuse by Program participants that bring into question the effectiveness of the Program's internal controls. Specifically, of the 46 SBIR investigations we closed since 2001, eight (17 percent) have resulted in criminal convictions, civil judgments, or administrative corrective action. Our investigative and audit work has shown that some SBIR contractors received awards from multiple agencies for essentially the same work, submitted different proposals to multiple agencies but then provided all of them the same deliverable, or misrepresented information including the role of a principal investigator who was supposed to perform the research. In addition to initiating a comprehensive audit of NASA's management of the SBIR Program that will focus specifically on assessing the adequacy and implementation of the Program's internal controls, the OIG recommended that

- the Agency consider whether the SBIR program represents a weakness in internal controls that warrant monitoring as part of the Agency's implementation of OMB Circular A-123, "Management's Responsibility for Internal Control";
- the Director, Innovative Partnerships Program, take into consideration the OIG's past audit and investigative work concerning the SBIR Program when conducting the Statement of Assurance Process for 2009; and
- the Senior Assessment Team discuss NASA's SBIR Program and consider whether the Program's internal controls represent a vulnerability that should be monitored.

NASA is taking action to address these recommendations.

Standards of Ethical Conduct Compliance. There is a great deal of interaction between NASA and the private sector, including both industry and academia. Again, given that approximately 90 percent of NASA's budget is dedicated to contracts and grants, there is great incentive for private sector interests to influence NASA employees. There is also substantial interaction between NASA's scientists and researchers and those working for non-governmental entities, and incentives abound for such acts as sharing information that is sensitive but unclassified.

Many NASA employees often seek to pursue financial opportunities in the private sector beyond their Government employment. With the interchange of talented personnel between the public and private sectors, the advent of term appointments, the use of Intergovernmental Personnel Act appointments, and the use of contractors to meet personnel needs, management is challenged to ensure that ethics laws and regulations applicable to each category are identified and followed. It is imperative that NASA employees, as stewards of NASA's mission and budget, are aware of and comply with the applicable ethics laws and regulations.

We believe that the Agency's commitment to ethics is crucial to maintaining the confidence of Congress and the taxpayer so that NASA can fulfill its mission to further science and technology and to explore the universe. NASA needs to meticulously scrutinize its processes for appointments to panels, boards, and committees that are charged with rendering independent evaluations of NASA programs and projects. The consequences of not having a strong commitment to ethics or of having a workforce that does not embrace a culture of ethical compliance not only undermines the public's trust in Government but inherently causes a further disruption in Agency programs, given the host of consequential activities such as bid protests, contract cancellations, and inquiries by the investigative arms of Congress and the OIG.

Following our April 2008 audit related to the establishment of the Orion Project's Standing Review Board (SRB), which found that 6 of the Orion SRB's 19 members were not fully independent of the Orion Project, we initiated a review of all Constellation Program SRBs to determine whether similar issues existed with their SRBs. Similarly, we found 21 SRB members—close to one third of all non-Federal Constellation Program SRB members—with conflicts of interest and determined that each of the SRBs for Constellation Program included at least one non-Federal Government employee who was conflicted. Specifically, each SRB included at least one non-Federal Government employee who was an employee or consultant of a NASA contractor with an interest in or contract with either Constellation Program or one of its projects. This condition occurred because NASA's procedures for determining the independence of an SRB member were inadequate. Specifically, because the SRBs met the definition of Federal Advisory Committee Act (FACA)¹³ committees but were not organized under FACA, they did not trigger the ethics review process associated with the establishment of FACA committees. Instead, NASA used a process that was lacking in both rigor and accuracy for determining independence of SRB members.

We do note the Office of the General Counsel's commitment to ethics compliance and awareness, as the Office expanded its resources in the past 3 years to focus on acquisition integrity. Nevertheless, ethics issues, for the Agency as a whole, still accounted for a significant number of cases and allegations examined by the OIG in recent fiscal years. Several of those investigations caused protracted procurements, some also led to criminal convictions of NASA employees. For example:

- A former Chief of Staff was convicted on Conflict of Interest and False Statement charges stemming from the steering of earmarked funds to a client of his private consulting company.
- An SBIR contractor submitted false financial reports and included family members on the company payroll.
- An Intergovernmental Personnel Act employee overcharged NASA for payroll and fringe benefit costs.
- A NASA scientist steered contracts to a company operated by his spouse.
- Source Evaluation Board information was leaked to a potential contractor during a bid protest.
- Employees were guilty of organizational conflicts of interest and unauthorized access to proprietary information.
- A former NASA employee used information gained from his position at NASA to give an unfair advantage to a prospective contractor.

Although many of the examples are still under investigation, and may not be violations of applicable laws or regulations, they are emblematic of the types of allegations that arise with a technical workforce that works closely with the private sector to accomplish NASA's mission.

The OIG continues to work with Agency ethics officials to identify and address these issues through both training and enforcement; prudence would dictate that the Agency continue to examine the effectiveness of its ethics training and processes, given the continued number of ethics allegations and instances identified.

¹³Title 5, United States Code Appendix, Sections 1–16, the Federal Advisory Committee Act (1972), as amended.

Information Technology (IT) Security

Although our focus is on NASA's need to strengthen its IT security program, we recognize that achieving this goal will occur through improvements in the Agency's overarching IT management practices. In the past, NASA has reported IT security as a material weakness in the Administrator's annual Statement of Assurance. Since then, NASA has implemented various solutions in an attempt to improve its IT security. These solutions have resulted in continued incremental improvements across NASA's IT infrastructure; however, challenges remain. Specifically, not all solutions have been fully implemented and ongoing breaches of NASA computer systems have resulted in the theft of sensitive data related to Agency programs, which adversely affected NASA's mission and resulted in millions of dollars in losses.

During FYs 2008 and 2009, the Agency reported taking steps to prevent future breaches of its computer systems by making progress on two key management initiatives related to IT security. First, NASA implemented the Cyber Threat Analysis Program to proactively detect and handle intrusions into NASA's cyber assets. The program includes threat analysis, identification, and reporting as well as advanced data forensics methods. Second, NASA initiated the Security Operations Center (SOC) project to consolidate Agency security operations and incident response capabilities. The SOC is expected to be fully operational in late FY 2010 and will provide the Agency with end-to-end visibility and real-time monitoring of its computer networks and systems. In addition, the Agency also reported making significant progress implementing corrective actions related to IT security weaknesses as well as meeting its annual requirements under the Federal Information Security Management Act (FISMA).

In 2008, the Office of the Chief Information Officer (OCIO) concluded that IT security no longer needed to be reported as a material weakness in the Administrator's annual Statement of Assurance, provided certain conditions were met. These conditions included substantiated progress implementing corrective actions related to IT security weaknesses, full implementation of the SOC, and favorable results from regular security compliance reviews. The OIG performed a limited review to independently assess NASA's actions. We found that NASA had closed 91 percent of the OIG recommendations to improve IT security in FYs 2005 through 2007, established the Cyber Threat Awareness Program, completed implementation planning for the SOC, and improved compliance with FISMA requirements for its systems to be certified and accredited. Based on our limited review, we agreed with the conclusion of the OCIO that IT security should no longer be reported as a material weakness. However, the threat to NASA's computer networks and systems is tangible and evolving—both in scope and sophistication. As such, much work remains to be done in order for NASA to fully implement a sufficient and reliable IT security program.

For example, we identified an issue during our FY 2008 FISMA audit concerning the reporting of NASA's national security systems. Each year, OMB provides a FISMA reporting template for agencies to use in their annual FISMA reporting. The issue we identified related to information the Agency included in its responses to OMB regarding its national security systems. The subsequent OIG audit found that NASA did not comply with FISMA requirements for the reporting of national security systems for FYs 2007 and 2008 because NASA had not clearly assigned this responsibility to a specific NASA office. Further, NASA had not formally designated an entity with appropriate resources to complete the annual independent evaluations of its national security systems required by FISMA.

As part of our FY 2009 FISMA audit, we reviewed system certification and accreditation packages, security control tests, and contingency plan tests for 24 Agency and 5 external systems.¹⁴ Our review sample included systems from all NASA Centers, NASA Headquarters, and the NASA Shared Services Center. We found that 89 percent of the 29 systems that we reviewed were certified and accredited. However, only 25 percent had security controls tested within the last year and only 50 percent met annual FISMA requirements for contingency plan testing. NASA also could not provide evidence of required contractor oversight for four of the five external systems in our sample. In addition, we found that only 2 percent of the plans of action and milestones (POA&Ms) related to the 29 systems reviewed addressed IT security weaknesses. Finally, results from a concurrent GAO audit of NASA's IT security program identified 129 weaknesses in controls that are intended to restrict access to NASA's data and systems.

The significance of the reported IT security weaknesses is brought into clearer focus when taken into account along with the burgeoning network-centric threats that NASA faces. NASA continues to undergo successful attacks as cyber attack technology, new phishing techniques, and spyware programs become more damaging with the advancement of technology. For example, in December 2008, three systems with regular access to a NASA Center's

¹⁴NASA Standard Operating Procedure, ITS-SOP-0033, "External System Identification and IT Security Requirements," July 19, 2007, defines an external system as an IT system used by NASA to store or process "NASA information that is critical to the mission or operations of NASA. . . . External systems are generally owned by outside agencies, contractors, universities, or other organizations and provide services to other customers besides NASA."

badging database were compromised. NASA was unable to determine whether the incidents resulted in the theft of personally identifiable information from the database because of a lack of data regarding the incident. However, the lack of adequate safeguards potentially exposed a significant number of employees of that Center to identity theft. In a separate incident at the same Center, intruders were able to steal large amounts of research data that included information protected under the International Traffic in Arms Regulations. The Center's lack of adequate access controls allowed the intruders accesses to a great deal of data across a number of programs. Although only one legitimate user's account had been compromised initially, poorly implemented access controls allowed the intruders to achieve much greater success than they would have realized in a more controlled network environment. NASA's efforts to improve its IT security and management should decrease the likelihood of similar incidents in the future.

Although the ongoing development and implementation of both the Cyber Threat Analysis Program and the SOC are representative of the Agency's progress, the Agency is still developing and implementing various other projects involving incident management. For example, the implementation of the SOC is still incomplete. Additional time will also be required to demonstrate the effectiveness of this program.

Improper Payments Information Act (IPIA) Assessment

Improper Payment Compliance

The National Aeronautics and Space Administration (NASA) is dedicated to reducing fraud, waste, and abuse by adequately reviewing and reporting programs susceptible to improper payments in accordance with the Office of Management and Budget (OMB) Circular A-123 *Management's Responsibility for Internal Control*, Appendix C, *Requirements for Effective Measurement and Remediation of Improper Payments*. To improve the integrity of the Federal government's payments and the efficiency of its programs and activities, Congress enacted the Improper Payments Information Act (IPIA) of 2002 (Public Law No. 107-300). The IPIA contains requirements in the areas of improper payment identification and reporting. It requires agency heads to annually review all programs and activities, identify those that may be susceptible to significant improper payments, estimate annual improper payments in susceptible programs and activities, and report the results of their improper payment activities.

In August 2006, OMB issued Appendix C of OMB Circular A-123—*Requirements for Effective Measurement and Remediation of Improper Payments*. Appendix C supersedes OMB's previous promulgations on improper payments and requires all Executive branch agencies to:

- **Review all of its programs and activities to identify those susceptible to significant improper payments. OMB defines significant improper payments as those in any particular program or activity that exceed both 2.5 percent of program payments and \$10 million annually.**
- **Obtain a statistically valid estimate of the annual amount of improper payments in programs and activities.**
- **Develop corrective action plans and reduction targets for programs and activities found to be susceptible to significant improper payments.**
- **Include, in the Performance and Accountability Report (PAR), an estimate of the annual amount of improper payments in programs and activities and the progress in reducing them.**

The IPIA defines an improper payment as any payment that should not have been made or that was made in an incorrect amount (including overpayments and underpayments) under statutory, contractual, administrative, or other legally applicable requirements.

NASA's IPIA assessment in fiscal years 2004 through 2008 resulted in improper payments less than 2.5 percent of program payments and less than \$10 million. With the assistance of contractor support, during fiscal year (FY) 2009, NASA continued its efforts to improve the integrity of its payments and the efficiency of its programs by conducting a risk assessment of its programs and activities. NASA identified the following eight programs as susceptible to improper payments:

- **Constellation Systems**
- **Cosmic Origins**
- **Earth Science Research**
- **Earth Systematic Missions**
- **Institutions and Management**
- **International Space Station**
- **Mars Exploration**
- **Space Shuttle Program**

Total payments related to these programs amounted to approximately \$5 billion in FY 2008. During FY 2009, with the assistance of contractor support, NASA performed an improper payment review of each program in accordance with Appendix C of OMB Circular A-123 and identified an estimated total of approximately \$822,359 in improper payments with a percentage estimate of 0.0197%. This annual estimate was based on NASA's FY 2008 data (October 1, 2007 to September 30, 2008). Although the testing performed found that the programs did not have significant improper payments, as defined by OMB A-123, Appendix C, NASA will continue to measure and report the annual amount of improper payments.

Improper Payments Information Act Reporting Details

The Improper Payments Information Act (IPIA) of 2002 requires Federal agencies to review their programs and activities annually to identify those programs that are susceptible to significant improper payments. The Office of Management and Budget (OMB) guidance defines significant improper payments as annual improper payments in a Line of Business or Program that exceed both 2.5 percent of program payments and \$10 million. Agencies are required to identify any programs and activities with significant improper payments, report the annual amount of improper payments, and implement corrective actions.

I. Risk Assessment

NASA's risk assessment for FY 2009 was developed using criteria established for determining levels of risk and evaluating all major programs against these criteria. Risk factors included conditions related to financial processing and internal controls, internal and external monitoring and assessments, human capital risk, programmatic risk, and the nature of programs and payments.

In FY 2009, NASA performed a comprehensive qualitative and quantitative risk assessment. NASA's risk assessment was conducted to identify those programs susceptible to significant improper payments. NASA used the following four-step methodology to update its risk assessment.

(1) Determine Scope of Programs Subject to Risk Assessment

NASA began its risk assessment by determining the population and scope of programs which would be subject to review. NASA derived its initial program scope based upon the FY 2008 total disbursements, and identified 84 distinct programs. NASA generated disbursement totals for each program from its financial management system. The aggregate disbursement total was validated against NASA's SF-133, *Report on Budget Execution and Budgetary Resources*. The number of in-scope programs was then reduced to 33 based on the materiality of disbursements.

(2) Develop Risk Matrix Elements

Once the scope of the risk assessment was finalized, NASA developed a web-based questionnaire to assist in the implementation of the assessment. The web-based questionnaire was designed to accurately capture and represent the relevant risk conditions facing NASA's programs, and measure the significance of those risk conditions for each program. The web-based questionnaire included risk conditions upon which NASA's programs would be evaluated and captured data such as risk assessment scores, disbursement values, and estimated error rates.

(3) Evaluate Risk Condition of In-scope Programs

NASA evaluated the risk condition of in-scope programs including factors such as the control environment, internal and external monitoring, human capital risk, programmatic risk, and the nature of program payments. Additionally, NASA compiled the results of a Risk Assessment web-based questionnaire that was completed by Senior Management and Program Personnel.

(4) Populate Risk Matrix and Identify Highly Susceptible Programs

Based on the results of the web-based questionnaire, interviews with process owners and review of several NASA Financial management reports such as the Independent Auditor's report, NASA populated the risk matrix with qualitative data for each program (and risk condition). The qualitative data was used in conjunction with the scoring criteria to assign a risk score to each risk condition. NASA used the risk condition scores and weighting formulas to determine an overall risk score, and identify programs susceptible to significant improper payments. As a result the following programs were identified:

- Constellation Systems
- Cosmic Origins

- **Earth Science Research**
- **Earth Systematic Missions**
- **Institutions and Management**
- **International Space Station**
- **Mars Exploration**
- **Space Shuttle Program**

Due to the results of the FY 2007 and FY 2008 improper payments assessments, four of the programs identified during the FY 2009 risk assessment were determined as not susceptible to improper payments. These programs were:

- **Institutions and Management**
- **International Space Station**
- **Mars Exploration**
- **Space Shuttle Program**

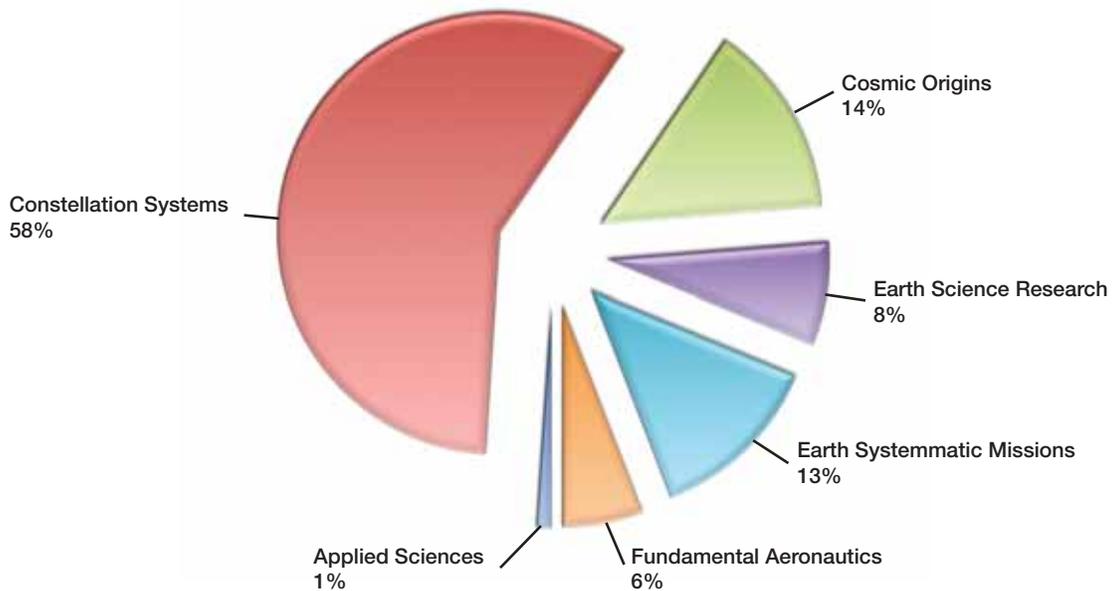
The Office of the Chief Financial Officer (OCFO) Quality Assurance Division (QAD) decided to not include the low risk programs in an effort to assess programs not previously reviewed during FY 2007 or FY 2008. Additionally, it was concluded that programs assessed and tested during the two previous years and rated low risk would establish the three year baseline for the NASA risk assessment and improper payment program.

Because only four programs were selected for testing, NASA took this opportunity to capitalize on its conservative approach by evaluating other programs for testing that would be receiving new funding as a result of the American Recovery and Reinvestment Act of 2009 (ARRA). As such, in order to identify additional relevant programs to include in the testing phase of the assessment, QAD considered the original scope of the FY 2009 risk assessment. Implementing a “hands-on” approach, QAD and Grant Thornton proceeded to identify those programs that would be recipients of ARRA funds. The rationale for this approach was to evaluate those programs receiving ARRA funds to determine if safeguards are in place to prevent significant improper payments. This approach would help QAD prevent future problems in regards to improper payments; ascertain potential payment issues; and place effective controls to mitigate issues in the years ahead.

The additional programs identified and added to the scope of the FY 2009 testing phase were:

- **Applied Sciences**
- **Fundamental Aeronautics**

**FY 2009 Programs Susceptible to High Risk of Significant Improper Payments,
As a Percentage of Total Susceptible Programs**



Detailed Amounts by Program

FY 2009 Susceptible Programs	Total Program Payments FY 2008
Applied Sciences	\$52,912,037.92
Constellation Systems	\$3,012,665,751.88
Cosmic Origins	\$734,769,036.40
Earth Science Research	\$387,129,675.96
Earth Systematic Missions	\$664,003,048.16
Fundamental Aeronautics	\$302,334,749.42
Total	\$5,153,814,299.74

II. Statistical Sampling

For each program identified as being susceptible to significant improper payments, NASA developed a statistically valid random sample of program payments in accordance with OMB guidelines and conducted tests of transactions in order to determine whether payments were proper or improper. NASA used a statistical random sampling method to yield an estimate with a 90 percent confidence level of plus or minus 2.5 percent for each program. A total number of 2,183 transactions were selected and investigated for the period of October 1, 2007 to September 30, 2008. The types of transactions included vendor payments, Government purchase card, and travel expenditures.

Description of Population and Sample Data

A random sample was selected for the period for each of the six programs identified as susceptible to significant improper payments. The following table shows the number of transactions and dollar value by program for the payment population and sample:

Number of Transactions and Dollar Value by Program

Program	Transactions		\$ Value	
	Population	Sample	Population	Sample
Applied Sciences	6,028	361	\$30,578,234.68	\$36,100,258.55
Constellation Systems	92,434	581	2,473,863,563.85	344,396,416.41
Cosmic Origins	23,494	269	679,310,000.78	663,746,161.38
Earth Science Research	20,233	250	592,217,208.97	66,458,558.50
Earth Systemmatic Missions	40,119	286	232,188,007.54	280,501,443.77
Fundamental Aeronautics	42,480	436	167,326,383.41	52,768,718.98
Total	224,788	2,183	\$4,175,483,399.23	\$1,443,971,557.59

The sampling methodology and sample selection for each program is described below:

Sampling Methodology: A stratified sampling approach was applied to estimate improper payments for all payment types in the programs selected for sampling.

Sample Selection: The population of payments included vendor payments, Government purchase card transactions, and travel expenditures in the defined testing period. A total of 2,183 items were selected and tested for the FY 2009 sample.

III. Conclusion

Based on the results of testing, NASA identified two improper payments for a gross total of \$254. An extrapolation of the two payments over the entire universe resulted in \$822,359 of estimated improper payments with an estimate percentage of 0.0197% during the period (October 1, 2007–September 30, 2008). These amounts are not considered significant as defined by OMB A-123, Appendix C and therefore NASA is not required to submit a written corrective action plan; however, NASA will implement corrective actions in FY 2010 to further reduce its exposure to improper payments.

The following table shows the total payments by population, sample amount, and annual estimate of improper payments by program.

FY 2009 Total Improper Payments by Program

Program	Dollars		FY 2009 Annual Estimate of Improper Payments	FY 2009 Estimate of Improper Payments
	Population	Sample		
Applied Sciences	\$ 30,578,235	\$ 36,100,259	0.3047%	\$ 93,178
Constellation Systems	2,473,863,564	344,396,416	0.0000%	–
Cosmic Origins	679,310,001	663,746,161	0.1073%	729,181
Earth Science Research	592,217,209	66,458,559	0.0000%	–
Earth Systemmatic Missions	232,188,008	280,501,444	0.0000%	–
Fundamental Aeronautics	167,326,383	52,768,719	0.0000%	–
Total	\$ 4,175,483,400	\$ 1,443,971,558	0.0197%	\$ 822,359

NASA identified the following type of improper payments:

Contract payments to vendors were paid after the due date—as defined by the Prompt Payment Final Rule —5 CFR 1315 in the Code of Federal Regulations. As a result, an interest penalty should have been applied to the vendor payment. The Prompt Payment Final Rule requires Executive departments and agencies to pay commercial obligations within certain time periods and to pay interest penalties when payments are late. These payments constituted underpayments. Specifically, the Applied Sciences transaction was two days late. Grant Thornton applied a 5.125% interest rate per Prompt Pay Interest Rate History Chart (fms.treas.gov/prompt/rates.html) to the transaction total (\$25,778) for an underpayment total of \$7. The Cosmic Origins transaction was three days late. Grant Thornton applied a 5.75% interest rate per Prompt Pay Interest History Chart to the transaction total (\$515,701) for an underpayment total of \$247. The total underpayment for the two transactions totaled \$254.

Recovery Audit

In accordance with the requirements of section 831 of the *Defense Authorization Act* of FY 2002, NASA performs recovery audits as part of its overall program of effective internal control over contract payments. In FY 2009 NASA performed a recovery audit focused on its FY 2007 disbursements.

In accordance with OMB guidance, agencies may determine to exclude classes of contracts and contract payments from recovery audit activities if the agency head determines that the recovery audits are inappropriate or not a cost-effective method for identifying and recovering improper payments. Consequently NASA does not include cost-type contracts in its assessment for recovery audits.

Last year NASA engaged an industry leader in recovery auditing under a contingency contract and FY 2006 disbursements were audited. This year, FY 2007 disbursements were audited and the results are listed in the following table. The Recovery Audit of FY 2008 disbursements currently is underway.

Agency Component	Amount Subject to Review for FY 2007 Reporting	Actual Amount Reviewed and Reported FY 2007	Amounts Identified for Recovery FY 2007	Amounts Recovered FY 2007	Amounts Identified for Recovery Prior Years (PYs)	Amounts Recovered (PYs)	Cumulative Amounts Identified for Recovery (CY + PYs)	Cumulative Amounts Recovered (CY + PYs)
NASA	\$4,740,930,555	\$4,740,930,555	\$1,714	\$1,714	\$207,838	\$204,567	\$209,552	\$206,281

The Agency has taken steps through the Improper Payment reviews and recovery audits to continue holding agency managers accountable for reducing and recovering improper payments. The Recovery Audit process is monitored by headquarters to ensure compliance with NASA's Recovery Audit Guidance. In addition, all collection and disbursement functions are now centralized at the NASA Shared Services Center which ensures not only prompt recovery of overpayments, but an effective way to control and review all contract payments.

NASA has the infrastructure and information technology in place to reduce improper payments. There are no statutory or regulatory barriers limiting NASA's ability to reduce improper payments.

FY 2009 Inspector General Act Amendments Report

Background

The *Inspector General Act* of 1978 (P.L. 95-452) requires that the head of each Federal agency make a final management decision on all audit recommendations issued by the Office of Inspector General (OIG) within a maximum of six months after the issuance of an audit report. The Act further requires that the head of each Federal agency attain final management action on each final management decision within 12 months after issuance of an audit report.

The *Inspector General Act Amendments* of 1988 (P.L. 100-504) added a requirement that the head of each Federal agency report on the status of final management decisions and final management action taken on OIG audit recommendations, as well as on the monetary benefits identified in those audit reports. Specifically, agency heads are required to report:

- The number of OIG audit recommendation for which a final management decision has not been made within six months after the date of a final audit report;
- The number of OIG audit recommendations for which final management action has not been achieved within 12 months after the date of a final report, and;
- The dollar amount of monetary benefits identified (i.e., disallowed costs and funds to be put to better use [FPTBU])

The following definitions are provided to enhance the readability of NASA's FY 2009 Inspector General Act Amendments Report:

A **Final Management Decision** (also referred to as resolution) occurs when an agreement is reached between Agency and OIG as to course of action to be taken with respect to an audit recommendation made by the OIG (or a contractor performing audit services for the OIG).

Final Management Action is the point in time when corrective action, taken by management in conjunction with a final management decision, is completed.

Corrective Action consists of remediation efforts on the part of management which are intended to mitigate an audit finding.

Questioned Costs identified by the auditors' result from an initial finding that incurred costs are either: a) not consistent with a provision of a law, regulation, contract, grant, cooperative agreement, or other agreement or document governing the expenditure of funds; (b) a finding that, at the time of the audit, such cost is not supported by adequate documentation; or (c) a finding that the expenditure of funds for the intended purpose is unnecessary or unreasonable.

Disallowed Costs are questioned costs that management has determined should not be charged to the Government.

Funds to be Put to Better Use (FPTBU) are funds that could be used more efficiently if management implemented audit recommendations. Efficiencies may result from: reductions in outlays; de-obligation of funds, or; costs not incurred by implementing recommended improvements related to operations of the agency, a contractor, or a grantee.

NASA's Audit Follow-up Program

NASA management is committed to ensuring the timely resolution of audit recommendations, coupled with the timely implementation and completion of related corrective actions. NASA management also believes that audit follow-up is essential to improving the efficiency and effectiveness of NASA programs, projects, and operations. In

this regard, NASA has implemented a comprehensive program of audit liaison, resolution, and follow-up (ALRFU) intended to ensure that OIG audit recommendations are resolved and corrective action is implemented and completed in a timely and effective manner.

NASA's Office of Internal Controls and Management Systems (OICMS) is responsible for policy formulation, oversight, and functional leadership of NASA's ALRFU program. OICMS operates in conjunction with a network of Audit Liaison Representatives (ALRs) imbedded within each of NASA's Mission Directorates, Mission Support Offices, Administrator's staff offices, and field Centers. This virtual team collectively provides the organizational structure to support NASA's ALRFU program.

In FY 2006, OICMS implemented the periodic assessment of the efficiency and effectiveness of NASA's audit follow-up program, based on requirements delineated in Office of Management and Budget Circular A-50, *Audit Follow-up*, dated September 29, 1982. These "Post-Closure Follow-up Reviews" (PCFR) have been conducted during FY 2006, FY 2007 and FY 2009. In general, the results have indicated that NASA's ALRFU results in the efficient, prompt, and proper resolution and corrective action on audit recommendations issued by the NASA OIG.

FY 2009 Audit Follow-up Results

1. Final Management Decision Pending—More than Six Months After Report Issuance

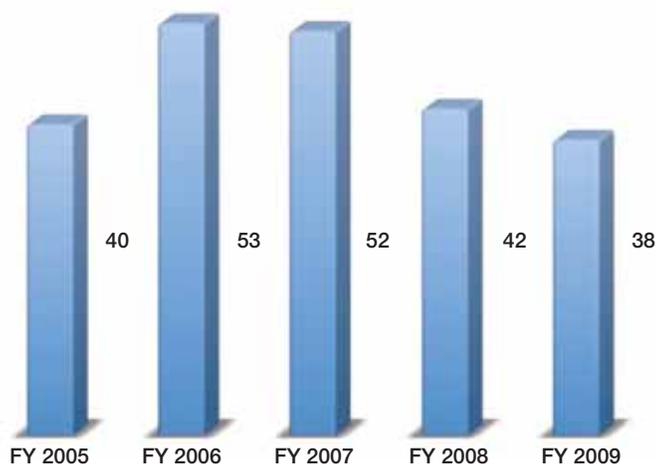
For the fiscal year ended September 30, 2009, there were no OIG audit recommendations pending a final management decision more than six months after the issuance of the associated audit reports.

2. Final Management Action Pending—One Year or More After Report Issuance

As of September 30, 2009, there were 18 OIG audit reports containing a total of 38 recommendations on which a final management decision had been made but final management action was still pending, one year or more after the issuance of the respective reports (see Table 1).

For comparative purposes, as of September 30, 2008, there were 17 audit reports containing 42 recommendations on which a final management decision had been made, but final management action was still pending one year or more after the issuance of the respective reports. For the five year period ended September 30, 2009, the number of OIG audit recommendations pending final management action one year or more after issuance of a final audit report ranged between 38 and 53. With the exception of two outlier years (FYs 2006 and 2007), the number of these audit recommendations has remained relatively static and have ranged between 38 and 42 (see Figure 1).

Figure 1: The Number of OIG Audit Recommendations Open More Than One Year



Frequently, the corrective action associated with a final management decision spans several reporting periods. This may be due to the complexity of the planned corrective action (which often times consists of the design, implementation, and testing of related systems or sub-systems); or the development, concurrence, and review process associated with NASA policy and/or procedural requirements. In spite of these constraints, NASA management continues to aggressively pursue the implementation of agreed-upon corrective action relating to audit recommendations issued by the OIG.

**Table 1: Summary of OIG Audit Reports Pending Final Management Action
One Year or More After Issuance of a Final Report
(As of September 30, 2009)**

Report No. Report Date	Report Title	No. of Recommendations	
		Open	Closed
IG04025 09-07-04	NASA's Implementation of the Mission Critical Space System Personnel Reliability Program	1	5
IG05016 05-12-05	NASA's Vulnerability Assessment Program	1	3
IG06007 03-21-06	NASA's Implementation of Patch Management Software is Incomplete	1	1
IG07006 11-15-06	FY 2006 NASA Financial Statement Audit Report	1	18
IG07003 11-20-06	Governance of the Systems, Applications, and Products Version Update Project Needs Improvement	1	5
IG07005 01-30-07	NASA's Draft Plan for Space Shuttle Transition Could Be Improved by Following Project Management Guidelines	1	3
IG07014 06-19-07	Controls over the detection, response and reporting of network security incidents needed improvement at 4 NASA Centers reviewed	4	4
IG07013 07-24-07	MSFC's Approach to PDM and MCAD Software Tools as Standard Center-Wide	1	2
IG07029 09-18-07	Final Memorandum on Education and Training Grants	1	2
IG08001 11-15-07	Audit of NASA's Fiscal Year 2007 Financial Statements	3	24
IG08004 12-11-07	NASA's Accounting for Real Property Leased to Other Entities	4	0
IG08005 12-11-07	Final Memorandum on NASA's Accounting for Capitalized Real Property Designated as Inactive	4	0
IG08018 04-28-08	Final Memorandum on the Standing Review Board to the Orion Crew Exploration Vehicle Project	7	1
IG08014 05-09-08	Review of the National Aviation Operations Monitoring Service	1	2
IG08017 06-02-08	Actions Needed to Ensure Scientific and Technical Information is Adequately Reviewed at Goddard Space Flight Center, Johnson Space Center, Langley Research Center, and Marshall Space Flight Center	1	6
IG08021 07-08-08	Review of NASA's Plan to Build the A-3 Facility for Rocket Propulsion Testing	1	1
IG08027 09-04-08	Glenn Research Center Needs to Better Define Roles and Responsibilities for Emergency Response	1	5
IG08025 09-19-08	Kennedy Space Center's Security Program Needed Improvement	4	4
18	Totals	38	86

3. Audit Reports with Disallowed Costs and/or Funds to Be Put to Better Use

During FY 2009, the OIG issued four audit reports which identified monetary benefits totaling \$16,411,200. Monetary benefits pending management disposition carried over from FY 2008 totaled \$300,000. Total monetary benefits (disallowed costs and funds to be put to better use) dispositioned by management during FY 2009 totaled \$16,711,200. No monetary benefits were pending final management action as of September 30, 2009 (see Table 2).

Table 2: Summary of Disallowed Costs and Funds to Be Put to Better Use

(For the Year Ended September 30, 2009)

Category	Disallowed Costs		Funds to Be Put to Better Use	
	Number of Reports	Dollars	Number of Reports	Dollars
1. Reports pending final management action at the beginning of the reporting period	–	\$0	1	\$300,000
2. Plus: Reports on which management decisions were made during the reporting period	4	\$16,411,200	–	–
3. Total reports pending final action during the reporting period (1 + 2)	4	\$16,411,200	1	\$300,000
4. Reports on which final action was taken during the reporting period	4	\$16,411,200	1	\$300,000
5. Audit reports pending final action at the end of the reporting period (3-4)	–	\$0	–	\$0

Summary of Financial Statement Audit and Management Assurances

The following tables summarize the Agency's FY 2009 material weaknesses. Table 1 summarizes the material weaknesses identified by the Financial Statement Auditor in their report on Internal Control. Table 2 summarizes the material weaknesses identified by NASA Management in the Statement of Assurance included in the Management Assurance section of this PAR.

Table 1: Summary of Financial Statement Audit

Audit Opinion	Disclaimer				
Restatement	Yes				
Material Weaknesses					
	Beginning Balance	New	Resolved	Consolidated	Ending Balance
Controls Over Legacy Property, Plant and Equipment	1	0	0	0	1
Financial Systems, Analyses and Oversight	1	0	1	0	0
Total Material Weaknesses	2	0	1	0	1

Table 2: Summary of Management Assurances

Effectiveness of Internal Control Over Financial Reporting (FMFIA 2)						
Statement of Assurance	Qualified					
	Beginning Balance	New	Resolved	Consolidated	Reassessed	Ending Balance
Material Weaknesses						
Controls Over Legacy Property, Plant and Equipment	1	0	0	0	0	1
Financial Systems, Analyses, and Oversight	1	0	1	0	0	0
Total Material Weaknesses	2	0	1	0	0	1
Effectiveness of Internal Control Over Operations (FMFIA 2)						
Statement of Assurance	Unqualified					
	Beginning Balance	New	Resolved	Consolidated	Reassessed	Ending Balance
Material Weaknesses						
Total Material Weaknesses	0	0	0	0	0	0
Conformance With Financial Management System Requirements (FMFIA 4)						
Statement of Assurance	See section below on FFMA Compliance.					
	Beginning Balance	New	Resolved	Consolidated	Reassessed	Ending Balance
Material Weaknesses						
Financial Systems, Analyses, and Oversight	1	0	1	0	0	0
Total Material Weaknesses	1	0	1	0	0	0
Compliance With Federal Financial Management Improvement Act (FFMIA)						
	Agency			Auditor		
Overall Substantial Compliance	No			No		
1. System Requirements met?				No		
2. Accounting Standards met?				No		
3. USSGL at Transaction Level met?				Yes		

Missions at a Glance

AIM is a two-year mission to study Polar Mesospheric Clouds (PMCs), Earth's highest clouds, which form an icy membrane 50 miles above Earth's surface at the edge of space. The primary goal of AIM is to explain why PMCs form and what causes changes in their behavior. www.nasa.gov/mission_pages/aim/index.html

Aqua is a major international Earth Science satellite mission. Launched on May 4, 2002, the satellite has six different Earth-observing instruments on board and is named for the mission's focus on water in the Earth system. Aqua collects approximately 89 gigabytes of data daily. www.nasa.gov/mission_pages/aqua/index.html

Aquarius is a focused satellite mission that measures global sea surface salinity. After its 2010 launch, it will provide a global view of salinity variability to enhance climate studies. NASA and the Space Agency of Argentina are currently developing the Aquarius. aquarius.gsfc.nasa.gov

Ares 1 is an in-line, two-stage rocket. NASA plans to use Ares I to launch Orion, the spacecraft intended to replace the Space Shuttle for NASA human spaceflight missions after the Shuttle's retirement in 2010. www.nasa.gov/mission_pages/constellation/ares/ares1/index.html

Aura was launched July 15, 2004, the Aura satellite studies Earth's ozone, air quality, and climate. www.nasa.gov/mission_pages/aura/main/index.html

CALIPSO uses a cloud profiling radar system to study the role that clouds and airborne particles play in regulating Earth's weather, climate, and air quality. CALIPSO combines an active lidar instrument with passive infrared and visible imagers to probe the structure and properties of thin clouds and aerosols over the globe. NASA launched CALIPSO on April 28, 2006 with the CloudSat satellite. http://www.nasa.gov/mission_pages/calipso/main/index.html

Cassini/Huygens was launched on a Titan IV rocket in October 1997, carrying NASA's Cassini orbiter and the European Space Agency's Huygens probe. The Cassini/Huygens' mission is providing data for a detailed study of Saturn, its rings, icy satellites, magnetosphere, and the environment of Titan. saturn.jpl.nasa.gov/index.cfm

Chandra X-ray Observatory, launched and deployed by Space Shuttle Columbia on July 23, 1999, is the most sophisticated X-ray observatory built to date. Since Earth's atmosphere absorbs the vast majority of X-rays, they are not detectable from Earth-based telescopes. Chandra will advance knowledge about the high-energy universe. nasascience.nasa.gov/missions/chandra

CINDI, launched on April 16, 2008, will study the elements that influence space weather near Earth's equator. www.nasa.gov/mission_pages/cindi/

CloudSat was launched with the CALIPSO satellite to study the role that clouds and aerosols play in regulating Earth's weather, climate and air quality. www.nasa.gov/mission_pages/cloudsat/mission/index.html

Cluster II, launched in July of 2000, is an investigation of Earth's magnetosphere using four identical spacecraft simultaneously. nasascience.nasa.gov/missions/cluster

COBE, launched on November 18, 1989, provided precise satellite measurements of cosmic radiation, which confirmed the Big Bang theory of the origin of the universe. nasascience.nasa.gov/missions/cobe

Constellation Program will create a new generation of spacecraft for human spaceflight, consisting primarily of the Ares I and Ares V launch vehicles, the Orion crew capsule, the Earth Departure Stage, and the Altair Lunar Lander. These spacecraft will be capable of performing a variety of missions, from International Space Station resupply to lunar landings. www.nasa.gov/mission_pages/constellation/main/index.html

Dawn will study the asteroid Vesta and dwarf planet Ceres, celestial bodies believed to have accreted early in the history of the solar system. The mission will characterize the early solar system and the processes that dominated its formation. Dawn launched in September of 2007. dawn.jpl.nasa.gov

EPOXI combines two exciting science investigations in a new mission that re-uses the Deep Impact spacecraft already in orbit around the Sun. The Extrasolar Planet Observation and Characterization (EPOC) investigation observed stars with giant planets, and the Deep Impact eXtended Investigation (DIXI) of comets will observe comet 103P/Hartley 2 during a close flyby in November 2010. www.nasa.gov/mission_pages/epoxi/index.html

GALEX is an orbiting space telescope that observes galaxies in ultraviolet light. Since its launch in 2003, the mission has surveyed tens of thousands of galaxies in ultraviolet light. The mission will reveal the history of star formation in the universe. nasascience.nasa.gov/missions/galex

Glory is a low Earth orbit scientific research spacecraft that collects data on Earth's atmosphere and climate system to determine if temperature increase and climate change are natural events or the effects of human influence. glory.gsfc.nasa.gov

GOES/POES is composed of two geostationary satellites and two polar orbiting satellites that operate in pairs to monitor the east and west coasts separately. They provide real-time weather data for short-term weather forecasting of severe weather, space environment monitoring, and research and development. The polar orbiting satellites provide global long-range weather forecasting, ensuring that non-visible data are no more than six hours old. goespoes.gsfc.nasa.gov/goes/index.html

GPM is one of the next generation of satellite-based Earth science missions that will study global precipitation such as rain, snow, and ice. nasascience.nasa.gov/missions/gpm

GRACE accurately maps variations in Earth's gravity field. GRACE launched on March 17, 2002, sending two identical spacecrafts into a polar orbit about 310 miles above the Earth. nasascience.nasa.gov/missions/grace

GRAIL is a dual satellite mission with high-quality gravity mapping capabilities that will be launched to the Moon to determine the structure of the lunar interior, from crust to core, and to advance understanding of the Moon's thermal evolution. nasascience.nasa.gov/missions/grail

Hayabusa, a Japanese mission launched in May 2009, will collect a surface sample of material from the small asteroid 25143 Itokawa and return the sample to Earth for analysis. It also is a technology demonstration mission. Other scientific objectives of the mission include detailed studies of the asteroid's shape, spin state, topography, color, composition, density, photometric and polarimetric properties, interior and history. neo.jpl.nasa.gov/missions/hayabusa.html

Hubble Space Telescope, launched on April 1990, is a large, space-based observatory which has revolutionized astronomy by providing unprecedented deep and clear views of the universe, ranging from our own solar system to extremely remote fledgling galaxies that began forming not long after the Big Bang 13.7 billion years ago. hubble.nasa.gov

IBEX, launched October 19, 2008, is a small satellite, about the size of a bus tire. IBEX is the first mission designed to map the entire region of the boundary of our Solar System while rotating Earth. nasascience.nasa.gov/missions/ibex

ICESat I, launched in February 2004, is the benchmark Earth Observing System mission for measuring ice sheet mass balance, cloud and aerosol heights, as well as land topography and vegetation characteristics. ICESat I has provided multi-year elevation data needed to determine ice sheet mass balance as well as cloud property information, especially for stratospheric clouds common over polar areas. Its mission will end in 2009, and it will be replaced by ICESat II, currently in formulation. icesat.gsfc.nasa.gov

International Space Station (ISS), which was begun in 1998 and will be completed by 2011. Scientists will continue daily research operations in its microgravity environment that spans several sciences, enhancing knowledge in the fields of biology, human biology, physics, astronomy, and meteorology. It also is a place to test space exploration technologies and capabilities. www.nasa.gov/mission_pages/station/main/index.html

IRAS, launched on January 25, 1983, was a joint project of the United States (NASA), the Netherlands (NIVR), and the United Kingdom (SERC) and was the first observatory to perform an all-sky survey at infrared wavelengths. lambda.gsfc.nasa.gov/product/iras/

Jason-1, launched on December 7, 2001, is an oceanography mission to monitor global ocean circulation, improve global climate predictions, and monitor events such as El Niño conditions and ocean eddies. sealevel.jpl.nasa.gov/mission/jason-1.html

Jason-2/OSTM, which launched June 20, 2008, follow the ocean surface topography measurements of TOPEX/Poseidon (T/P) and the Jason-1 mission, and extends the time series of observations to two decades. sealevel.jpl.nasa.gov/mission/ostm.html

JDEM, a planned mission of NASA and the U.S. Department of Energy, will be an observatory containing a telescope and appropriate focal plane instruments to investigate dark energy. nasascience.nasa.gov/missions/jdem

Juno will significantly improve understanding of the formation, evolution, and structure of Jupiter. It will answer critical science questions about Jupiter, as well as provide key information to dramatically enhance present theories about the early formation of the solar system. nasascience.nasa.gov/missions/juno

JWST is a large, infrared-optimized space telescope that will find the first galaxies that formed in the early universe. It will peer through dusty clouds to see stars forming planetary systems. nasascience.nasa.gov/missions/jwst

Kepler, launched on March 6, 2009, is surveying our region of the Milky Way galaxy to discover hundreds of Earth-size and smaller planets in or near the habitable zone and determine the fraction of the hundreds of billions of stars in our galaxy that might have such planets. www.nasa.gov/mission_pages/kepler/main/index.html

LADEE will orbit the Moon, characterizing the atmosphere and lunar dust environment. LADEE implements an early priority of the National Research Council's 2007 report, *The Scientific Context for the Exploration of the Moon*, namely to "determine the global density, composition, and time variability of the fragile lunar atmosphere before it is perturbed by further human activity." nasascience.nasa.gov/missions/ladee

LCROSS launched with LRO on June 18, 2009. The main LCROSS mission objective is to confirm the presence or absence of water ice in a permanently shadowed crater near a lunar polar region. www.nasa.gov/lcross/

LDCM follows the Landsat mission and provides continuous satellite acquisition of high-resolution multispectral data of Earth's surface on a global basis. The data from the Landsat spacecraft constitute the longest record of the Earth's continental surfaces as seen from space, unmatched in quality, detail, coverage, and value. lcm.nasa.gov

LRO will spend at least one year in a low polar orbit approximately 31 miles above the lunar surface, while its seven instruments find safe landing sites, locate potential resources, characterize the radiation environment, and test new technology. www.nasa.gov/LRO

MAVEN will provide the first direct measurements ever taken to address key scientific questions about Mars' evolution: Mars once had a denser atmosphere that supported the presence of liquid water on the surface. As part of a dramatic climate change, most of the Martian atmosphere was lost. MAVEN will make definitive scientific measurements of present-day atmospheric loss that will offer clues about the planet's history. www.nasa.gov/mission_pages/mars/news/maven_20080915.html

MESSENGER, launched on August 3, 2004, is a scientific investigation of the planet Mercury, the least explored terrestrial planet. MESSENGER will be the second mission to visit Mercury, and the first to orbit the planet. nasascience.nasa.gov/missions/messenger

MMS is a Solar-Terrestrial Probe mission that will be comprised of four identically instrumented spacecraft. It will use Earth's magnetosphere as a laboratory to study the microphysics of three fundamental plasma processes: magnetic reconnection, energetic particle acceleration, and turbulence. nasascience.nasa.gov/missions/mms

MRO, launched August 12, 2005, is on a search for evidence that water persisted on the surface of Mars. nasascience.nasa.gov/missions/mars-reconnaissance-orbiter

MSL is a large, roving laboratory that will collect and analyze dozens of soil and rock samples while exploring the planet with greater range than any previous Mars rover. As planned, the robotic laboratory will carry the most advanced payload of scientific gear ever used on Mars' surface, a payload more than 10 times as massive as payloads on earlier Mars rovers. nasascience.nasa.gov/missions/msl

OCO was the latest mission in NASA's ongoing study of the global carbon cycle. It was the first spacecraft dedicated to studying atmospheric carbon dioxide, the most significant human-produced greenhouse gas and the principal human-produced driver of climate change. Due to a launch failure, the spacecraft was lost before reaching orbit (see Sub-goal 3A in the *Detailed Performance* section for more information). www.nasa.gov/mission_pages/oco/main/index.html

Opportunity, one of the Mars Exploration Rovers, landed on Mars on January 25, 2004. The rover was originally designed for a 90 Sol mission (a Sol, one Martian day, is slightly longer than an Earth day at 24 hours and 37 minutes). NASA extended this mission several times as the rover continued to make new and profound discoveries about the planet. nasascience.nasa.gov/missions/mars-rovers

Orion, also known as the Crew Exploration Vehicle, will send the next generation of explorers to the Moon, the ISS, Mars, and other destinations in the solar system. www.nasa.gov/mission_pages/constellation/orion/index.html

Parasol, a French Earth science mission, is the second microsatellite in the Myriade series that was launched on December 18, 2004. Parasol uses wide-field imaging instruments designed to improve our knowledge of the radiative and microphysical properties of clouds and aerosols by measuring the directionality and polarization of light reflected by the Earth-atmosphere system. smc.cnes.fr/PARASOL/

Phoenix, launched August 4, 2007, studied the history of water in the Martian arctic and searched for evidence of a habitable zone, and assessed the biological potential of the ice-soil boundary. nasascience.nasa.gov/missions/phoenix

Rosetta, a spacecraft on a 10-year mission to catch the comet "67P/Churyumov-Gerasimenko" (C-G), will be the first spacecraft to soft-land a robot on a comet. Rosetta will also be the first spacecraft to accompany a comet as it enters our inner solar system, observing at close range how the comet changes as the Sun's heat transforms it into the luminous apparition that has frightened and inspired people for centuries. rosetta.jpl.nasa.gov

Scout is a four-stage, solid fuel satellite system capable of launching a 385-pound satellite into a 500-mile orbit. There have been 118 Scout launches, and its overall 96-percent success rate has earned this workhorse a spot in the National Air and Space Museum. www.nasa.gov/centers/langley/news/factsheets/Scout.html

SOHO, launched on December 2, 1995, is a project of international collaboration between European Space Agency and NASA to study the Sun from its deep core to the outer corona and the solar wind. sohowww.nascom.nasa.gov/about/about.html

Spitzer Space Telescope launched August 25, 2003. During its cryogenic mission, Spitzer obtained images and spectra by detecting the infrared energy, or heat, radiated by objects in space. Most of this infrared radiation is blocked by Earth's atmosphere and cannot be observed from the ground. nasascience.nasa.gov/missions/spitzer

STEREO, launched in October 2006, is providing a unique and revolutionary view of the Sun-Earth system. The two observatories, one ahead of Earth in its orbit, the other trailing behind, trace the flow of energy and matter from the Sun to Earth. www.nasa.gov/mission_pages/stereo/main/index.html

TDRS is the communication satellite component of the Tracking and Data Relay Satellite System, which provides tracking and data acquisition services between low Earth orbiting spacecraft and control and/or data-processing facilities. The system is capable of transmitting to and receiving data from spacecraft over at least 85 percent of the spacecraft's orbit. The first TDRS was launched in 1983 on the Space Shuttle *Challenger's* first flight, STS-6. nssdc.gsfc.nasa.gov/multi/tdrs.html

THEMIS, launched in February 2007, aims to resolve one of the oldest mysteries in space physics: to determine what physical process in near-Earth space initiates the violent eruptions of the aurora that occur during sub-storms in Earth's magnetosphere. www.nasa.gov/mission_pages/themis/mission/index.html

TOPEX/POSEIDON, launched on August 10, 1992, monitored global ocean circulation, improved global climate predictions, and tracked El Niño conditions and ocean eddies. After over 62,000 orbits, the satellite has ceased operations. nasascience.nasa.gov/missions/topex-poseidon

TRACE, launched in April 1998, enables solar physicists to study the connections between fine-scale magnetic fields and the associated plasma structures on the Sun in a quantitative way by observing the photosphere, the transition region, and the corona. trace.lmsal.com

TRMM is a joint mission between NASA and the Japan Aerospace Exploration Agency (JAXA) monitors and studies tropical rainfall. The satellite was launched on November 27, 1997 from the Tanegashima Space Center in Tanegashima, Japan. trmm.gsfc.nasa.gov

Ulysses, launched on October 6, 1990, was the first mission to survey the space environment above and below the poles of the Sun. solarsystem.nasa.gov/missions/profile.cfm?MCode=Ulysses

WISE is a satellite that will carry an infrared-sensitive telescope that will image the entire sky, providing a vast storehouse of knowledge about the solar system, the Milky Way, and the universe. Among the objects WISE will study are asteroids, the coolest and dimmest stars, and the most luminous galaxies. wise.ssl.berkeley.edu/mission.html

WMAP is a NASA Explorer mission that launched June 2001 to make fundamental measurements of cosmology, the study of the properties of our universe as a whole. WMAP has been stunningly successful, producing our new Standard Model of Cosmology. WMAP continues to collect high-quality scientific data. nasascience.nasa.gov/missions/wmap

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